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U.S. ARMY ENVIRONMENTAL CENTER

WOODBRIDGE RESEARCH FACILITY REMEDIAL INVESTIGATION/FEASIBILITY STUDY

Sampling and Analysis Plan
Volume I: Field Sampling Plan

FINAL DOCUMENT

FEBRUARY 1996

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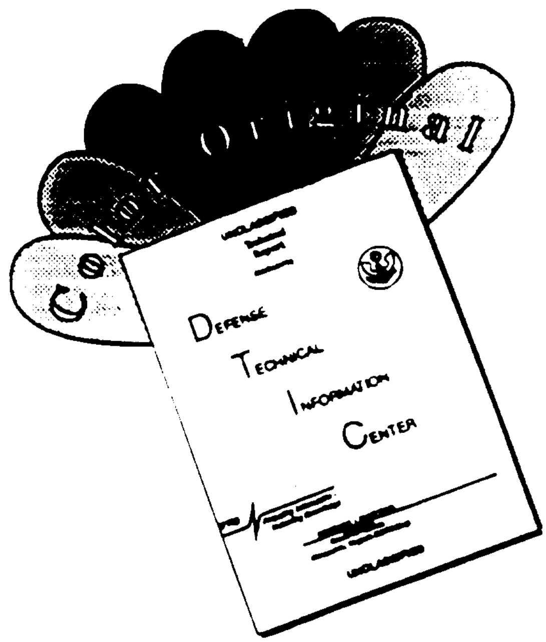

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13. ABSTRACT (*Maximum 200 words*)

U.S. Army Woodbridge Research Facility (WRF) was used in the past as a major military communications center and a research and development laboratory where electromagnetic pulse energy was tested on military and other equipment. WRF is presently an inactive facility pursuant to the 1991 Base Realignment and Closure list. Past investigation activities indicate that polychlorinated biphenyl compounds (PCBs) are primary chemicals of concern. The WRF is presently in the process of being turned over to the United States Fish and Wildlife Service (USFWS) to be used as a wildlife refuge and training facility. This task calls for provision of the necessary staff and equipment to provide remedial investigation/feasibility support for the USAEC BRAC Program investigation at WRF. The scope of work includes Focused Feasibility Studies, Remedial Investigations, Feasibility Studies, ecological assessments, risk assessments, proposed plans, RODs, and community relations support. This Field Sampling Plan contains a description of the site, sample location rationale, technical approach to field operations, site safety procedures, and methods for ecological assessments, analyses of samples, data management, and disposal of investigation-derived wastes. Information contained in other plans which accompany this submittal is identified.

14. SUBJECT TERMS

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SAMPLING AND ANALYSIS PLAN
VOL I: FIELD SAMPLING PLAN
FOR DELIVERY ORDER NO. 0001
WOODBRIDGE RESEARCH FACILITY
REMEDIAL INVESTIGATION/FEASIBILITY STUDY

FINAL DOCUMENT

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1.0 INTRODUCTION

ICF Kaiser Engineers (ICF KE) has been contracted by the U.S. Army Environmental Center (USAEC) to conduct a Remedial Investigation/Feasibility Study (RI/FS) for the U.S. Army Woodbridge Research Facility (WRF). WRF is located in Prince William County, Virginia, approximately 22 miles southwest of Washington, D.C. In July of 1991, WRF was recommended for closure by 1991 Base Realignment and Closure (BRAC 91). This task will be performed under Contract No. DACA31-94-D-0064, Delivery Order 0001. A Remedial Investigation (RI) will be conducted at the facility to evaluate the nature and extent of contamination associated with past disposal practices and to evaluate the level of risk posed to human health and the environment. The goal of the RI is to gather and present information which will allow appropriate risk management decisions to be made regarding evaluation and selection of remedial actions at the site.

An integral part of the Sampling and Analysis Plan is the Field Sampling Plan (FSP). The FSP is the detailed sampling and data collection guidance document that enables a field team to competently conduct the field work necessary to support the RI. In addition to this FSP, a Quality Assurance Project Plan (QAPP), a Health and Safety Plan, and a Work Plan have been developed for this site. Although WRF is not a Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) site, this FSP follows, with the exception of limited modifications, the philosophy and intent of the Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final, May 1987 (USEPA, 1987).

The FSP contains detailed instructions regarding the following:

- collection of groundwater samples from newly-installed and existing monitoring wells;
- monitoring well and piezometer installation;
- collection of subsurface soil samples from both drilling operations and test pit excavation;
- collection of surface soil samples;
- collection of surface water and sediment samples from various drainage basins;
- collection of storm water runoff samples downgradient of potentially contaminated areas; and
- measurement of surface water elevations using staff gauges.

This study is being performed under the purview of the USAEC, United States Environmental Protection Agency (USEPA) Region III, and the Virginia Department of Environmental Quality (VDEQ) and fully complies with the Health and Safety Plan included with this submittal.

1.1 FIELD SAMPLING OBJECTIVES

The overall objective of this task is to conduct an RI/FS of WRF. An RI will be conducted in areas requiring environmental evaluation (AREEs) and a facility-wide baseline risk assessment will be generated. Additional objectives and the planned approach to meeting these objectives are as follows:

- *Evaluate the nature and extent of potential sources of contamination at the facility that have not already been identified by previous investigations.* Test pits will be excavated at previously identified subsurface geophysical anomalies and dump sites, for which no data have been collected to date, to determine whether they are potential contaminant sources.

- *Evaluate the general nature and extent of surface and subsurface contamination at the facility, which may contribute to adverse environmental effects or unacceptable human health or environmental risks.* Additional monitoring wells, borings, piezometers, surface soil, surface water and sediment sample locations will be installed and/or sampled to determine the nature and extent of contamination.

- *Refine the current understanding of the nature and extent of contamination at the site and whether observable impacts have occurred or could occur.* A program of physical, chemical, and biological sampling is planned to address this objective.

1.2 SAMPLING AND ANALYSIS PLAN ORGANIZATION

The FSP is organized into ten sections as follows:

Section 1.0 - Introduction: This section presents the general RI approach and FSP organization.

Section 2.0 - Site Background: This section describes the site background and physical setting of the WRF.

Section 3.0 - Sample Location Rationale: This section provides the rationale for monitoring well, soil boring, and surface soil sample locations. For each of the listed media, the number of samples to be collected, and the location for each, is specified.

Section 4.0 - Technical Approach to Field Operations: This section describes the procedures for field activities including determination of a decontamination water source, installation and development of groundwater monitoring wells, and test pit excavation.

Section 5.0 - Site Safety Procedures and Logistics: This section briefly outlines the Health and Safety protocols that will be employed for the WRF RI/FS.

Section 6.0 - Ecological Assessments: This section identifies the protocols for assessing the habitats and general ecology of WRF.

Section 7.0 - Physical and Chemical Analysis of Environmental Samples: This section summarizes the chemical and physical analytical methods to be used for samples that are collected.

Section 8.0 - Data Management: This section describes the organization of the data management system including the reporting of data through the Installation Restoration Data Management Information System (IRDMIS).

Section 9.0 - Disposal of Investigation-Derived Wastes: This section describes the procedures for the disposal of investigation-derived wastes including decontamination water, purge water, personal protective equipment, uncontaminated solid waste, and potential contaminated soil.

Section 10.0 - References

2.0 SITE BACKGROUND

The following sections present existing information regarding WRF. This includes information describing the site history, physical setting of the area, and a summary of past activities possibly contributing to current WRF environmental problems.

2.1 PHYSICAL SETTING

WRF occupies 579 acres, and is situated in the easternmost portion of Prince William County, Virginia, as shown in Figure 2-1. The town of Woodbridge is located less than 1.5 miles west of WRF and has a population of 30,860 (1991 estimate). The site is 22 miles southwest of Washington, D.C.

U.S. Census Bureau Tract No. 9001.00, which encompasses WRF and the land immediately adjacent to the facility, contains an estimated 1,216 residents (1991). This tract is generally bounded by the RF&P railroad tracks on the west.

The site was used primarily for agricultural purposes, especially in the northern portion, prior to construction of WRF in 1951.

The property immediately adjacent to the north boundary of the WRF (and to the east of Dawson Beach Road) is presently being developed into a private golf course, which will include residential housing as well as a marina. To the north of the WRF (and to the west of Dawson Beach Road), the installation is adjoined by a former military housing area as well as by commercial property.

The facility is bounded on the west by Marumsco Creek and the Marumsco National Wildlife Refuge tidal wetlands. West of Marumsco Creek is Veteran's Memorial Park, a recreation area administered by Prince William County.

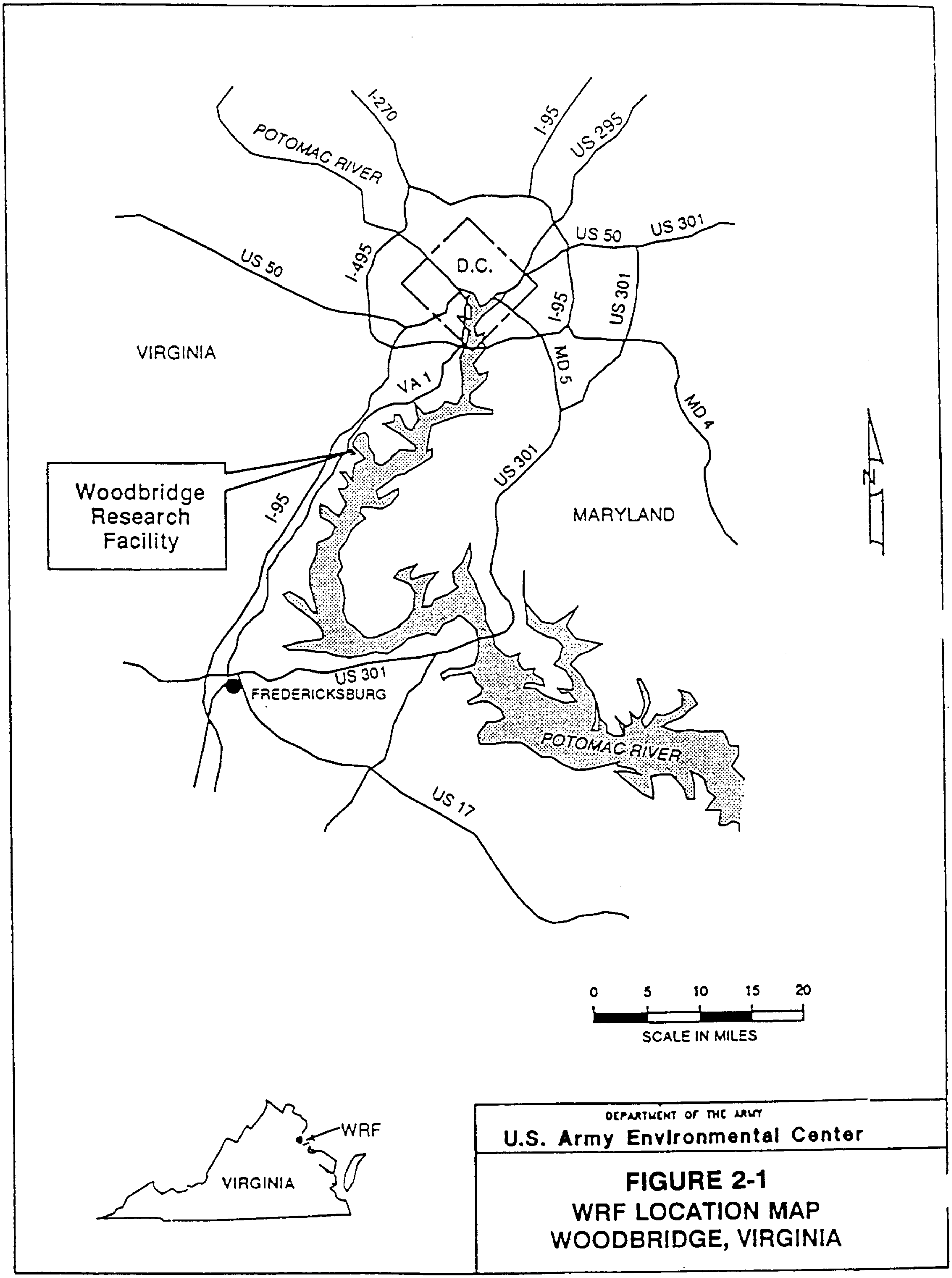
2.1.1 Climatology

The climate at WRF is variable, influenced by the Chesapeake Bay and the Atlantic Ocean to the east and the Appalachian Mountains to the west. The weather in the WRF area is characterized by cold, dry, continental-polar winds from the west and northwest during the winter, and maritime-tropical winds from the south and southwest, which bring warm, often humid air to the region during the summer. During the summer, occasional air pollution episodes are created when high-pressure systems stagnate over the area.

Rainfall averages 38.88 inches per year. Snowfall averages less than 10 inches per year. The maximum recorded snowfall was 25 inches, which fell in January 1922 (NRMP, 1991). The annual mean daily temperature for the area is 57 degrees Fahrenheit (°F). The monthly mean temperature ranges from 29°F in January to 90°F in July. The growing season, based on average first and last killing frosts, is from April 15 to October 15 (ESE, 1981). Prevailing winds are generally from the south in the summer months and the north to northwest in the winter months. The average wind speed is 7.1 miles per hour (mph).

2.1.2 Site Physiography and Topography

WRF lies within the western portion of the Coastal Plain Physiographic Province, approximately 8 miles east of the fall line that separates the Coastal Plain Physiographic Province from the Piedmont Physiographic Province. The facility is located on a neck of land at the southern edge of the embayed mouth of the Occoquan River, where it empties into Belmont Bay and Occoquan Bay, which in turn, feed the Potomac River and the Chesapeake Bay. The northern portion of the facility is situated on the post-



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U.S. Army Environmental Center

FIGURE 2-1
WRF LOCATION MAP
WOODBRIDGE, VIRGINIA

Pleistocene terrace of the Potomac, while the southern portion of the facility is marsh, underlain by alluvium from Potomac River and Occoquan River terrace deposits.

WRF is located in the drainage basin of the Occoquan Watershed and is composed primarily of terrace and alluvial deposits from the Potomac River and the ancestral Potomac River. Cobbles and gravels originate from the ancestral Potomac and include a variety of cherts, rhyolite, silicified sandstone, and quartz. Tributary streams, such as the Occoquan River and Marumsco Creek also carry this material as they cut through the various cobble deposits and quartz float and veins in the adjacent Piedmont. Some larger cobbles and boulders possibly originated from ice rafting mechanisms (Ward, 1991) associated with late Sangamon glaciation.

2.1.3 Soil Types

The general soil types found in the eastern Woodbridge vicinity are the Dumfries-Lunt-Marr soil association (Prince William County USDA Soil Survey, 1989). Six soil types have been identified at WRF specifically and are described below.

- Delanco Series. These soils are very deep and moderately-drained. They formed on alluvial terraces on the Piedmont Plateau, and are subject to rare flooding. Slopes range 0 to 4 percent.

- Dumfries Series. The soils of the Dumfries series are typically very deep and well-drained. They formed in feldspathic sandy sediments of the Coastal Plain. These soils are found on narrow ridges and side slopes. Slopes range from 7 to 50 percent.

- Elsinboro Series. These soils are very deep and well-drained. They formed in sediments dominantly derived from schist, gneiss, and granite of the northern Piedmont Plateau. They are found on low stream terraces adjacent to floodplains. Flooding is rare. Slopes range from 2 to 7 percent.

- Featherstone Series. The soils of the Featherstone series are very deep and very poorly-drained. They formed in Coastal Plain sediments at an elevation of less than 2 feet. The water table is commonly at the surface, and most areas are subject to ponding. Slopes range from 0 to 1 percent.

- Marumsco Series. These soils are very deep and moderately well-drained to somewhat poorly drained. They formed in stratified marine sediments of the low Coastal Plain Terraces. These soils are found in depressional areas. Slopes range from 0 to 4 percent.

- Meadowville Series. These soils are very deep and well-drained to moderately well-drained. They formed partly in colluvial materials and partly in materials weathered from muscovite, schist, and gneiss. They are found in depressional areas on toe slopes, along drainage ways, and in saddle positions in the northern part of the Piedmont Plateau. These soils are flooded for very brief periods after heavy rains. Slopes range from 0 to 5 percent.

2.1.4 Regional Geology

WRF is located on the unconsolidated sands, clays, and silts of the Atlantic Coastal Plain Physiographic Province. The Coastal Plain sediments begin at the Fall Line and thicken to the east and southeast. The sediments are underlain by undifferentiated Paleozoic meta-sedimentary and meta-igneous rocks. Two wells installed into the lower Potomac aquifer in the central part of the WRF site encountered bedrock at a depth of approximately 150 feet below ground surface (bgs). Locally, the unconsolidated sediments include the Potomac Group of the Cretaceous age, which are overlain by terrace and alluvial deposits of Pleistocene and Holocene age.

The Potomac group consists of three different facies that thicken from a feather edge along the northwest margin of outcrop in Dale City and Agnewville, to about 300 feet in the Marumsco Woods area of Woodbridge.

The more abundant facies, denoted Type 1, consists of crossbedded very light gray to pinkish gray, or greenish-gray, medium-to-coarse feldspathic quartz sand locally oxidized to yellow, orange, and brown. The matrix is clay-silt that may constitute 40 percent or more of the sediment. Gravelly sands contain pebbles and cobbles of vein quartz and quartzite or, less commonly, other metamorphic rock types. The sediments in the Type 1 facies probably represent channel-lag and channel-bar or point-bar deposits.

Type 2 facies consists of greenish-gray silty clay; clayey silt; and clayey, fine sand commonly mottled red or reddish-brown. Clay-silt plugs are commonly formed, ranging from 2 to 10 ft in thickness and 60 ft or more in width, within a dominantly medium to coarse sand sequence. These plugs may be the result of filling of abandoned stream channels by fine sediments during flood stages.

The Type 3 facies occurs as thin to thick beds within Type 1 sediment, suggesting deposition in swampy areas of floodplains. These sediments consist of dark yellowish-brown to olive-gray lignitic sandy silt and clay containing well-preserved leaf and stem impressions of ferns, cycads, and gymnosperms.

Gravelly and sandy deposits (QT2 and QP2) underlie the lower two terraces of ancestral Potomac and Occoquan Rivers. These deposits occur under terraces in valleys of Pohik Creek and Giles Run and are graded to the same level as the more extensive Potomac River terraces in adjacent areas. Units correlate with Potomac River deposits mapped in the Quantico quadrangle (Mixon *et al.,* 1972)

QT2 deposits consist of loose-crossbedded medium to coarse feldspathic quartz sand, partly pebbly, and massive to thick-bedded clayey and silty sand commonly pale yellowish-gray to reddish-gray. Pebbles are mostly quartz, metamorphic rocks of various types, red shale, and sandstone. The unit is very poorly exposed within the map area, but representative sections are well exposed in wave-cut cliffs bordering Occoquan Bay.

QP2 deposits consist of sand, gravel and feldspathic quartz sand very similar to QT2 deposits. Basal beds are commonly cobble gravel composed mainly of quartz, quartzite, and lesser amounts of chert and sandstone. These deposits are confined to small hilltop areas near the mouth of the Occoquan River and to the Gunston Heights area of Mason Neck. QP2 is much more extensive east and northeast of the map area in the northern part of Mason Neck, lower Pohick Creek drainage basin, and in the vicinity of Fort Belvoir.

The alluvium deposits of Holocene age consist of mud, sand, and gravel that form narrow floodplains along minor streams. These deposits include mud, muddy sand, and peat in swamps and marshes bordering tidal tributaries of the Potomac River and may include some colluvium.

2.1.5 Hydrogeology

Groundwater availability in the Coastal Plain sediments is generally good, although the limited areal extent and relatively thin sediments in Prince William County restrict development volumes.

Groundwater from the Coastal Plains sediments is soft to moderately- hard and contains low to moderate amounts of dissolved mineral matter. The water is harder along the western margin of the Coastal Plain near the Fall Line and is softer to the east. The iron content is commonly excessive and the water is acidic to slightly alkaline. Fluoride is often present, although not in excessive amounts, and bicarbonate is the most common nonmetal ion. Sulfate, nitrate, and chloride may also be present (VWCB,1991).

The water table is rarely flat, usually displaying undulations conforming to the topography. The depths to the water table are variable, ranging from at or near land surface in low marshy areas, to within 3 feet of land surface in the topographically flat areas, and to an undetermined depth below land surface in higher, better-drained areas. However, the relief of the water-table surface is more subdued than the topographic relief.

The variation of water-table elevation and gravity cause movement of the groundwater. Groundwater flows through the interconnected pore spaces in sediment and in fissures in rock. The rate of movement ranges from a few inches per year to a few feet per day. During the site characterization of the area adjacent to Building 202, Earth Technology Corporation performed rising and falling head slug tests on 5 monitoring wells installed in the shallow portion of the aquifer. An average hydraulic conductivity value of 3.1 ft/day for the upper portion of the aquifer in this area was calculated from the results of these slug tests. (USAEC, 1994c)

Coastal Plain sediments are typically high-yielding aquifers due to the presence of laterally-connected sand beds. The average yield for four wells with depths to less than 200 feet in the Coastal Plain is 101 gallons per minute (gpm); for 9 wells with depths between 200 and 400 feet, 137 gpm; and for two wells with depths from 400 to 600 feet, 21 gpm. However, in the aquifer beneath WRF, the sand beds comprise a much smaller proportion of the sediments than the clay beds; therefore, wells tend to yield less water than would typically be expected.

2.1.6 Surface Water

2.1.6.1 Surface Water Flow. The facility is located in the Occoquan River drainage basin of the Occoquan watershed. Marumsco Creek bounds WRF on the southwest and drains into Occoquan Bay. The Occoquan Bay bounds the facility to the south. Belmont Bay, which is located on the facility's northeast side, is mainly fed by the Occoquan River. The facility is bisected by an unnamed creek originating from residential and partly-industrialized areas to the north. This creek flows around the main compound, and is fed by several smaller drainages before discharging to Belmont Bay. Several additional drainages are found on the property. These waters are tidal tributaries of the Potomac River and are classified by the Commonwealth of Virginia as Class II (tidal fresh) waters.

2.1.6.2 Lithology of Sediment. The lithology of the bottom sediment within Marumsco Creek and the drainage ditches located within WRF is controlled by current-velocity distributions. Coarse-grained materials are typically found in the areas where current velocities are insufficient to transport these materials and yet sufficient to transport the fine-grained materials. Organic-rich, fine-grained material settles out of suspension in more dormant areas of creeks and drainage ditches. Tidal currents in Belmont and Occoquan Bays are such that their bottom sediments are composed of sand, which is coarser along the shoreline due to wave action.

3.0 SAMPLE LOCATION RATIONALE

To evaluate the nature and extent of contamination and extend the current database on the lithology and stratigraphy underlying WRF, the following field activities will be conducted: drilling; subsurface soil sampling; monitoring well installation with associated groundwater sampling; and surface soil, sediment, and surface water sampling. A hydrogeologic model for the WRF will be developed for the site based on data collected for the RI. Monitoring wells will be installed in background locations to determine site background subsurface soil conditions and site background groundwater quality. Background surface soil, sediment, and surface water samples will be collected to establish background ranges for each media.

Monitoring wells will be installed at selected areas to evaluate the extent of subsurface soil contamination and groundwater contamination as further detailed in Section 4.2. Therefore, the monitoring wells have been located in areas where further data concerning groundwater quality is needed. A total of 34 monitoring wells (29 shallow and 5 deep wells) will be installed.

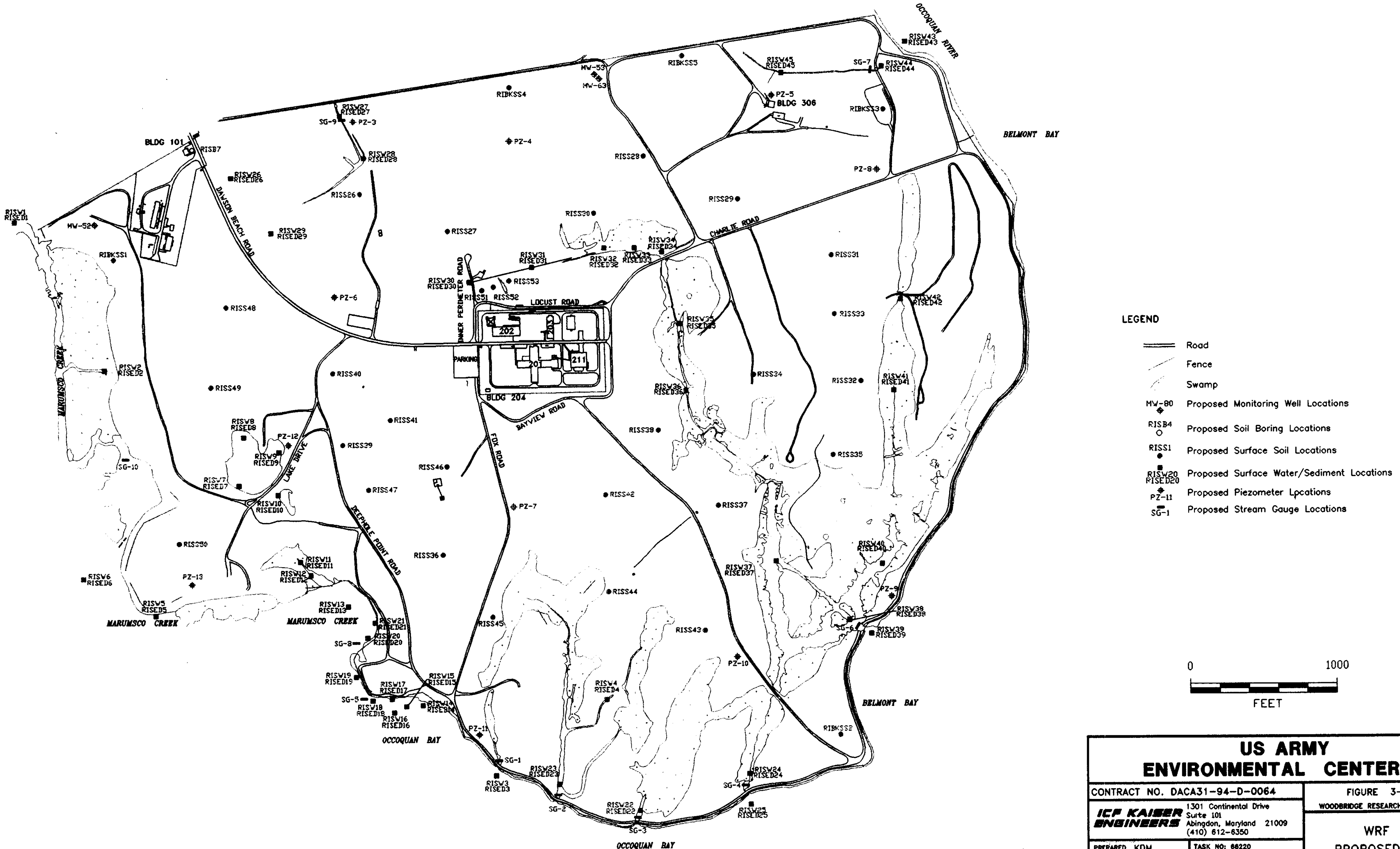
In addition, in areas where monitoring wells are not required, soil borings will be installed to investigate potential subsurface soil contamination. A total of 18 soil borings will be completed. Piezometers will be installed in 11 of the soil borings to supplement water-level data to further refine groundwater flow paths at the WRF. Surface water and sediment samples will be collected to evaluate the extent of contamination associated with these media.

This section describes the rationale for the selection of locations for further investigation, based primarily on past investigations conducted at WRF. Figure 3-1, presents the WRF RI Proposed Sample Locations for surface soil samples, surface water, sediment samples (except for surface water/sediment background samples), piezometers, and staff gauge locations. Proposed and previous sample locations for AREEs 1 through 7 are presented in Figures 3-2 through 3-4) and the AREEs associated with the Main Facility Compound are presented in Figures 3-5 and 3-6). The proposed sampling program has been designed to fill in "data gaps" from previous investigations. This section also presents the sample location rationale for background samples, and Areas Requiring Environmental Evaluation (AREEs) which have been identified during previous investigations. The areas proposed for further investigations, sample media, number of samples, and rationale are summarized in Table 3-1, WRF RI/FS Sampling Program. Table 3-1 is presented at the end of this section. A listing of all AREEs at WRF are summarized in Table 1-1 of the Workplan, and are also presented in the Workplan in Figures 1-2 and 1-3.

3.1 FACILITY BACKGROUND LOCATION RATIONALE

Background monitoring wells will be located in an area upgradient of the facility to establish background subsurface soil and groundwater quality. Surface soil samples will be collected to establish site background soil conditions. The proposed locations were selected based on past facility operations. No indications of past soil disturbance have been identified for these locations based on examination of aerial photographs and review of site investigation reports.

Three soil borings will be drilled and completed as monitoring wells to evaluate site background subsurface soil characteristics and groundwater quality. The background borings will be completed as monitoring wells. Two soil borings/monitoring wells, MW-53 and MW-63, will be drilled along the northern boundary of WRF. The proposed total depths of these wells are 35 feet below ground surface (bgs) and approximately 75 feet bgs, respectively. One soil boring/monitoring well, MW-52, will be drilled on the northwest side of WRF and completed to approximately 35 feet bgs. The locations of the background wells are presented in Figure 3-1. Groundwater samples will be analyzed for Target Compound List (TCL)volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs),



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PREPARED KDM	TASK NO: 68220	FIGURE 3-1 WOODBRIDGE RESEARCH FACILITY
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pesticides/polychlorinated biphenyls (PCBs), Target Analyte List (TAL) metals, polychlorinated triphenyls (PCTs), polyaromatic hydrocarbons (PAHs) and total petroleum hydrocarbons (TPH) to further characterize groundwater quality. Subsurface soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs and TPH. Subsurface soil samples will not be collected from MW-63 because this well will be drilled utilizing mud rotary techniques. Refer to Section 4.2.2 for drilling techniques.

Five surface soil samples (RIBK-1 through RIBK-5) will be collected and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, PAHs, TAL metals, PCTs, and TPH. The locations of the background surface soil samples are presented in Figure 3-1.

3.2 SAMPLING LOCATION FOR RATIONALE FORMER DUMP AREAS

This section describes the rationale for further investigations associated with AREEs 1 through 5, 6A, 6B, and 7, which are the former dump areas and pistol range. This area is bounded on the south by the Occoquan Bay, and on the west by the Marumsco Creek Wildlife Refuge.

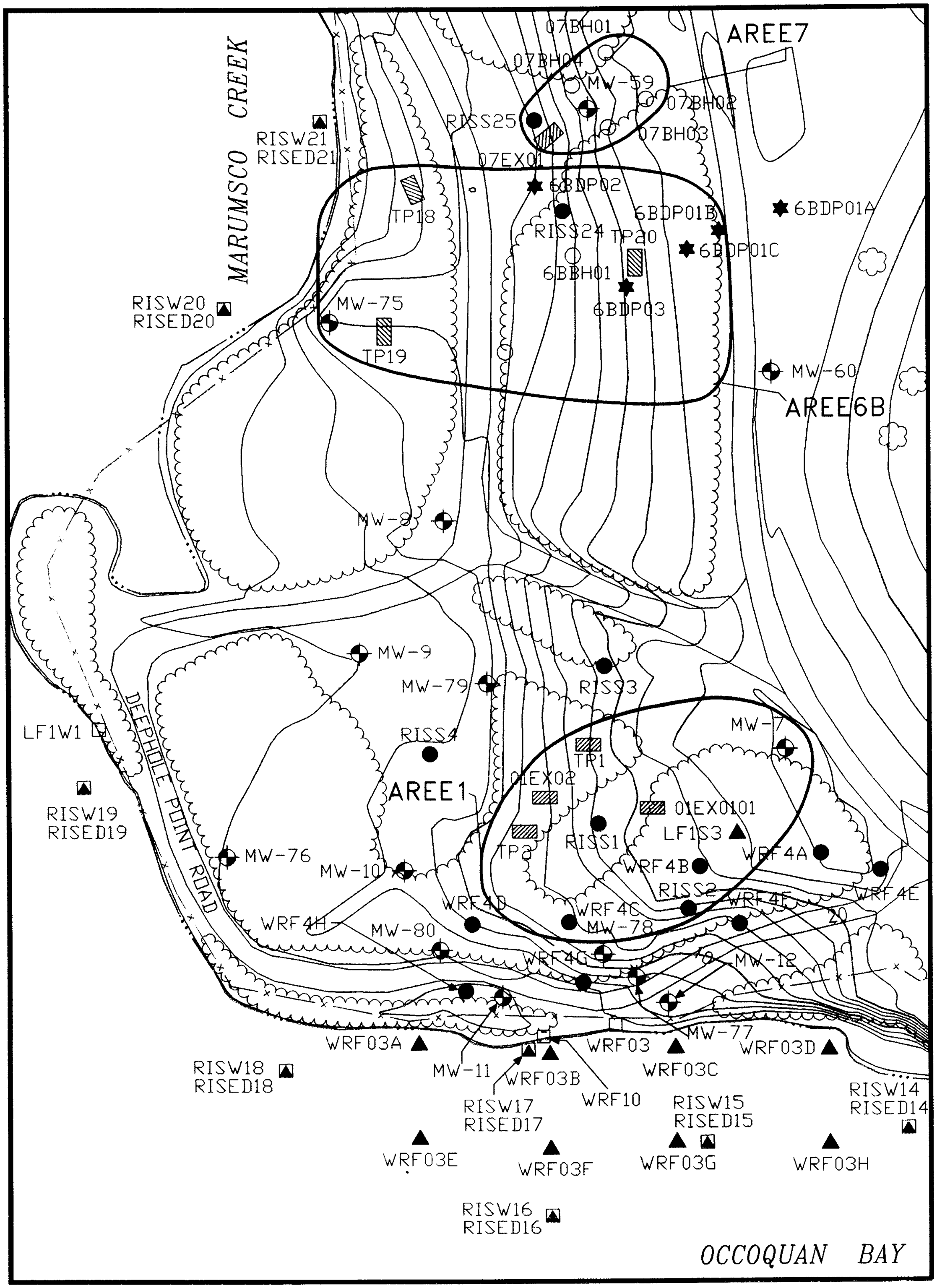
3.2.1 Downgradient Locations

Based on the limited data available from past investigations, it is presumed that the groundwater flow direction in the vicinity of the former dump areas is toward Marumsco Creek and Occoquan Bay. Two monitoring wells and one piezometer will be installed in locations downgradient of the former dump areas to evaluate groundwater quality prior to off-site flow. Two wells (MW-75, MW-76) will be located downgradient along the facility boundary near AREEs 1, 6B, and 7. One piezometer (PZ-13) will be located west/southwest of AREE 2 near the facility boundary and used for groundwater elevation data to develop the groundwater model. Figures 3-2 and 3-3 present the locations of monitoring wells MW-75 and MW-76, and piezometer PZ-13, respectively.

Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, TPH, and PAHs. Subsurface soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH.

3.2.2 AREE 1 - Former Dump No. 1

AREE 1 is a 0.4-acre former dump site located on the southwest portion of the WRF, and is bordered by Marumsco Creek and Occoquan Bay. Several sampling events have been performed since 1984 as discussed below. The locations of samples collected from previous investigations are presented in Figure 3-2. An investigation of this AREE was performed by Environmental Science and Engineering, Inc. (ESE) as part of an RI conducted in 1984 (ESE, 1985). The RI results revealed low concentrations of PCBs in sediment (Sample LF1S3). Bis (2- ethylhexyl) phthalate and di-n-octyl phthalate were detected in a surface water sample (Sample LF1W1) collected downgradient from the landfill area. Six monitoring wells, one upgradient (MW-7) and 5 downgradient (MW-8 - 12), were installed as a result of this investigation. The wells were sampled periodically from 1985 though 1990 and PCBs were detected. The highest concentrations were detected in MW-10 at 2 μg/L. While these concentrations have been reported, the data were suspected of being unreliable and the monitoring program was terminated. Follow-up investigations were conducted in 1993 by USAEC which included geophysical surveys to locate buried debris, followed by trenching at geophysical anomalies (i.e., areas identified as potential dump sites), and soil sampling in trench locations as well as resampling of the existing monitoring wells. PCBs were detected at 74 μg/g and 31 μg/g from 2 trench samples, 01EX0201 and 01EX0202, respectively, collected at a depth of six feet bgs. No PCBs were detected in groundwater. Samples of surface water, sediment, and soil were collected at AREE 1 (sample locations WRF03, WRF03A through WRF03H, WRF04, WRF04A through WRF04H, and WRF10) and the results were reported in the Virginia Department of Environmental



LEGEND

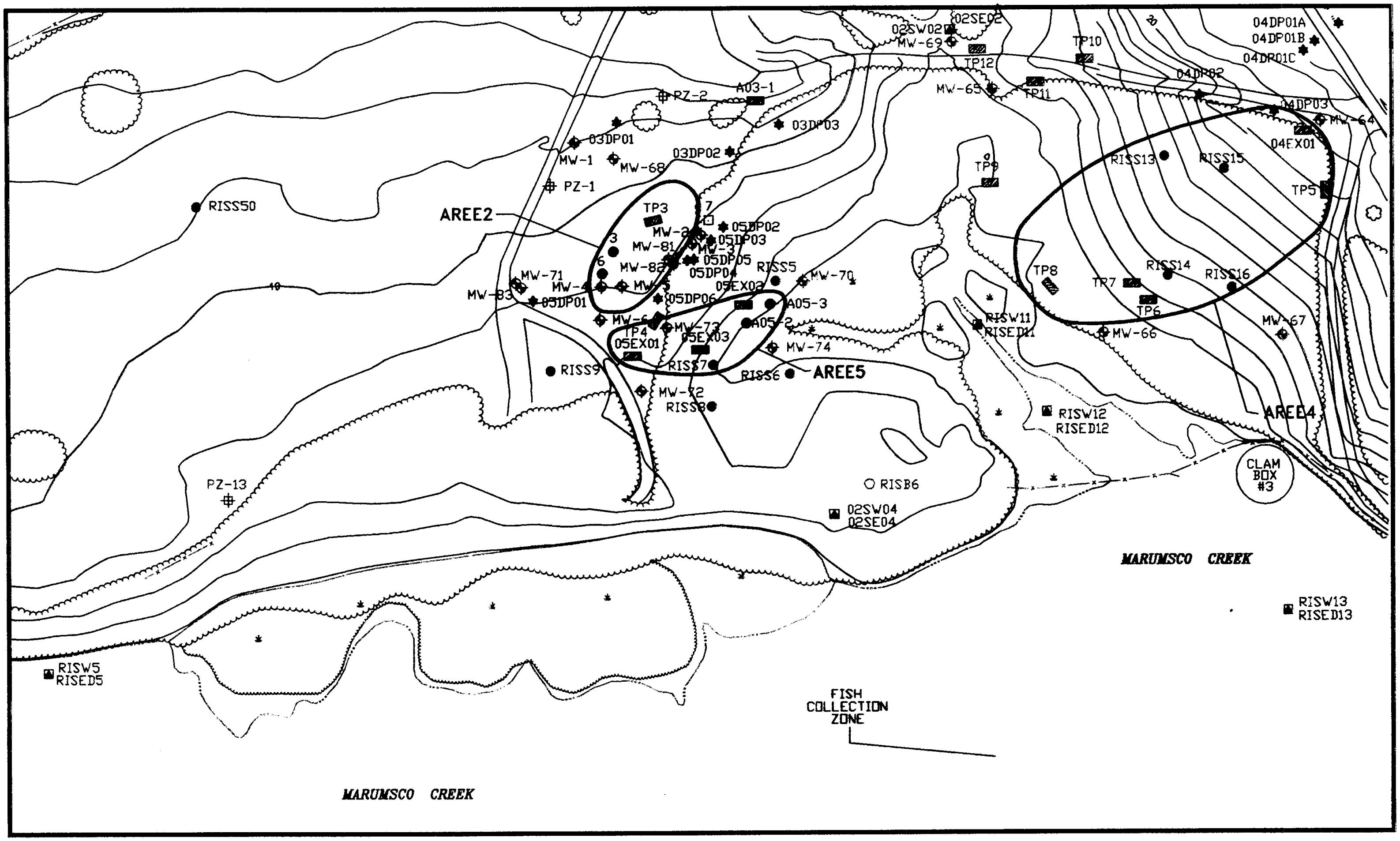
	SWAMP	MW-35	PRIOR MONITORING WELL LOCATION
	TREELINE	MW-59	PROPOSED MONITORING WELL LOCATION
	ROADS	12BH02	PRIOR SOIL BORING LOCATION
	EXCAVATION	RISB2	PROPOSED SOIL BORING LOCATION
	FENCE LINE	11SW01 11SE01	PRIOR SURFACE WATER/SEDIMENT LOCATION
	TOPOGRAPHIC CONTOUR (CONTOUR INTERVAL 2 FEET)	RISW31 RISED31	PROPOSED SURFACE WATER/SEDIMENT LOCATION
	CLAM BOX LOCATION	08SS0102	PRIOR SURFACE SOIL LOCATION
	FISH COLLECTION ZONE	RISS60	PROPOSED SURFACE SOIL LOCATION
	AREE LOCATION	A22-4	PRIOR SEDIMENT LOCATION
		12EX0102	PRIOR EXCAVATION LOCATION
		TP10	PROPOSED TEST PIT LOCATION
		7	PRIOR SURFACE WATER SAMPLE LOCATION
		PZ-2	PRIOR PIEZOMETER LOCATION
		PZ-12	PROPOSED PIEZOMETER LOCATION
		6ADP03	PRIOR DEEP PUNCH LOCATION

N

0 75
SCALE FEET

US ARMY ENVIRONMENTAL CENTER

CONTRACT NO. DACA31-94-D-0064	FIGURE 3-2
ICF KAISER ENGINEERS 1301 Continental Drive Suite 101 Abingdon, Maryland 21009 (410) 612-6350	ABERDEEN PROVING GROUND
PREPARED KDM / TASK NO: 66220	PRIOR AND PROPOSED SAMPLING LOCATIONS FOR AREES 1, 6B AND 7
CHECKED JC / ICF DWG NO:	
DATE 07-13-95 / AREE16B7	



LEGEND

		SWAMP
		TREELINE
		ROADS
		EXCAVATION
		FENCE LINE
		TOPOGRAPHIC CONTOUR (CONTOUR INTERVAL 2 FEET)
		CLAM BOX LOCATION
		FISH COLLECTION ZONE
		AREE LOCATION
MW-35		PRIOR MONITORING WELL LOCATION
MW-59		PROPOSED MONITORING WELL LOCATION
12BH02		PRIOR SOIL BORING LOCATION
RISB2		PROPOSED SOIL BORING LOCATION
11SW01 11SE01		PRIOR SURFACE WATER/SEDIMENT LOCATION
RISW31 RISED31		PROPOSED SURFACE WATER/SEDIMENT LOCATION
08SS0102		PRIOR SURFACE SOIL LOCATION
RISS60		PROPOSED SURFACE SOIL LOCATION
A22-4		PRIOR SEDIMENT LOCATION
12EX0102		PRIOR EXCAVATION LOCATION
TP10		PROPOSED TEST PIT LOCATION
7		PRIOR SURFACE WATER SAMPLE LOCATION
PZ-2		PRIOR PIEZOMETER LOCATION
PZ-12		PROPOSED PIEZOMETER LOCATION
6ADP03		PRIOR DEEP PUNCH LOCATION

N

0 150
SCALE FEET

US ARMY ENVIRONMENTAL CENTER

CONTRACT NO. DAAA15-91-D-0014

ICF KAISER ENGINEERS
1301 Continental Drive
Suite 101
Abingdon, Maryland 21009
(410) 612-6350

PREPARED KDM
CHECKED JC
DATE 06-24-95
TASK NO: 04306
ICF DWG NO: AREES245

FIGURE 3-3
ABERDEEN PROVING GROUND
PRIOR AND PROPOSED SAMPLING LOCATIONS FOR AREES 2, 4 AND 5

Quality's Bioaccumulation Initiative in Virginia's Coastal Zone Management Area Report (NOAA, 1994). PCBs were detected in sediment, surface water and surface soil. Table 3-2 lists the concentrations of analytes detected from past investigations of AREE 1. The proposed additional sampling for this RI/FS, as described below, will aid in determining the ultimate remedial action to be implemented at AREE 1. The proposed sampling locations for this RI are presented on Figure 3-2.

3.2.2.1 Groundwater/Subsurface Soil. The groundwater flow direction in the vicinity of AREE 1 is from east to west, based on the groundwater elevation contours reported in the final Site Inspection Report, May 1995, (USAEC, 1995) with groundwater discharge toward Marumsco Creek and Occoquan Bay. Four downgradient soil boring/monitoring wells (MW-77, MW-78, MW-79, and MW-80) will be installed. The proposed locations are closer to the known area of PCB contamination than the existing wells and will be used to further characterize and evaluate subsurface soil and groundwater contamination in AREE 1. In addition, the existing wells (MW-7 through MW-12) will be sampled. Groundwater samples from AREE 1 will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and PCTs to further characterize groundwater. Subsurface soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and PCTs.

3.2.2.2 Surface Soil. Four surface soil samples (RISS1-4) will be collected to characterize the extent of surface soil contamination. One surface soil sample (RISS1) will be collected from an area where a drum is protruding from the side of the hill. The remaining samples will be collected from areas where stressed vegetation has been observed or in run-off areas. Soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and PCTs.

3.2.2.3 Test Pits. Two test pits (TP1 and TP2) will be excavated upgradient and downgradient, respectively, of the two trenches (Trenches 20 and 21) previously excavated and sampled during the 1993 USAEC SI to determine the extent of PCB contamination. Two soil samples will be collected from each test pit and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and PCTs.

3.2.3 AREEs 2 and 5 - Former Dumps 2 and 5

AREEs 2 and 5 are sites of former landfills where transformers, capacitors, and metal debris were buried. These disposal areas are located adjacent to each other as shown in Figure 3-4. The area is located on a topographic high and groundwater in the area is presumed to flow topographically downgradient toward Marumsco Creek. The proximity of these AREEs to each other is such that they should be evaluated as one source area. Therefore, the proposed sampling locations (described in Sections 3.2.3.1 through 3.2.3.3), both upgradient and downgradient, encompass both AREEs. Previous site investigations related to AREEs 2 and 5 are presented below. Sample locations from past investigations as well as the proposed soil boring/monitoring well locations, test pits, and surface soil sample locations for this RI are presented in Figure 3-3. Tables 3-3 and 3-4 list the maximum concentrations of analytes detected from past investigations for AREEs 2 and 5, respectively.

Surface soil and surface water samples were collected in 1984 as part of an RI (ESE, 1985). PCB-1016 was detected in surface soil samples at 2 μg/g (Landfill 2, No. 3, 330802) and 200 μg/g (Landfill 2, No. 6, 330805) and PCB-1260 was detected at 3 μg/g in Landfill 2, No. 6, 330805. Sample locations are presented in Figure 3-3 and are depicted as sample locations 3 and 6. Six monitoring wells were also installed by ESE around AREE 2 in 1984 , and a removal action was completed by Weston in 1985 to remove transformers, capacitors, and contaminated soil. A five-year groundwater sampling program was implemented from 1985 to 1990 to monitor PCB contamination. The PCB concentrations have been increasing annually with concentrations of up to 7 μg/L detected in samples collected from MW-2 and MW-3 (Weston, 1992). However, five of the six monitoring wells were sampled again by Earth Tech in 1993 as part of the USAEC SI and no PCBs or VOCs were detected in the groundwater. Di-n-octylphthalate and bis(2-ethylhexyl) phthalate were detected at concentrations of 28 μg/L and 25 μg/L,

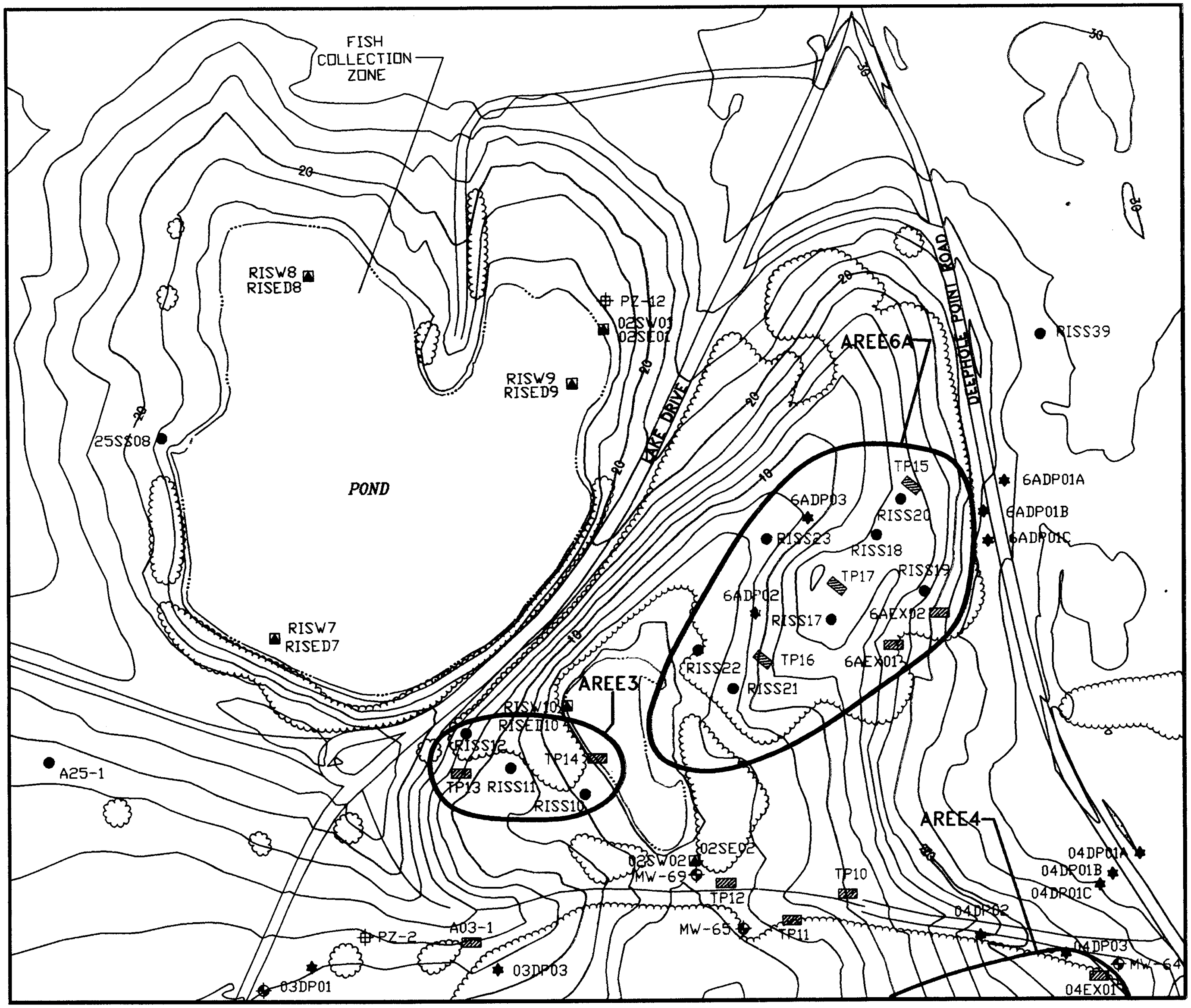
Table 3-2
Detected Concentrations of Analytes from Previous Investigations of AREE 1

Sample ID Number	Bis(2-ethylhexyl) phthalate	Di-noctylphthlate	Total PCBs[1]	PCB-1260	PCB-1254	PCB-1242
Surface Water (μg/L)						
LF1W1	25	32	ND	ND	ND	ND
WRF03	ND	ND	ND	15	ND	ND
Groundwater (μg/L)						
MW-10	NA	NA	2	NR	ND	NR
Sediment (μg/g)						
LF1S3	ND	ND	NR	0.2	ND	ND
WRF03B[3]	ND	ND	NR	ND	4.7	ND
WRF03E[3]	ND	ND	NR	34	ND	ND
WRF03F[3]	ND	ND	NR	26	ND	ND
WRF03G[3]	ND	ND	NR	6.86	ND	ND
Soil (μg/g)						
01EX0101	NA	NA	NR	ND K	ND	0.244 K
01EX0201	NA	NA	NR	74 K	ND	ND
01EX0202[2]	NA	NA	NR	31 K	ND	ND
WRF04A[3]	NA	NA	NR	135	ND	ND
WRF04B[3]	NA	NA	NR	180	ND	ND
WRF04C[3]	NA	NA	NR	35	ND	ND

Table 3-2 (Continued)
Detected Concentrations of Analytes from Previous Investigations of AREE 1

Sample ID Number	Bis(2-ethylhexyl) phthalate	Di-noctylphthlate	Total PCBs[1]	PCB-1260	PCB-1254	PCB-1242
WRF04E[3]	NA	NA	NR	29	ND	ND

PCB - Polychlorinated Biphenyl
AREE - Area Requiring Environmental Evaluation
ND - Not Detected
NA - Not Analyzed
NR - Not Reported
K - Missed holding times for extraction and preparation
[1] - Aroclors 1221, 1232, 1242, 1248, and 1254 reported in micrograms per liter (μg/L). Data not considered reliable; not confirmed in IRDMIS
[2] - Replicate
[3] - Concentration reported in micrograms per kilogram (μg/kg).



LEGEND

	SWAMP
	TREELINE
	ROADS
	EXCAVATION
	FENCE LINE
	TOPOGRAPHIC CONTOUR (CONTOUR INTERVAL 2 FEET)
	CLAM BOX LOCATION
	FISH COLLECTION ZONE
	AREE LOCATION
MW-35	PRIOR MONITORING WELL LOCATION
MW-59	PROPOSED MONITORING WELL LOCATION
12BH02	PRIOR SOIL BORING LOCATION
RISB2	PROPOSED SOIL BORING LOCATION
11SW01 11SE01	PRIOR SURFACE WATER/SEDIMENT LOCATION
RISW31 RISED31	PROPOSED SURFACE WATER/SEDIMENT LOCATION
08SS0102	PRIOR SURFACE SOIL LOCATION
RISS60	PROPOSED SURFACE SOIL LOCATION
A22-4	PRIOR SEDIMENT LOCATION
12EX0102	PRIOR EXCAVATION LOCATION
TP10	PROPOSED TEST PIT LOCATION
7	PRIOR SURFACE WATER SAMPLE LOCATION
PZ-2	PRIOR PIEZOMETER LOCATION
PZ-12	PROPOSED PIEZOMETER LOCATION
6ADP03	PRIOR DEEP PUNCH LOCATION

N

0 150
SCALE FEET

US ARMY ENVIRONMENTAL CENTER

CONTRACT NO. DAAA15-91-D-0014

ICF KAISER ENGINEERS, 1301 Continental Drive, Suite 101, Abingdon, Maryland 21009, (410) 612-6350

PREPARED KDM | CHECKED JC | DATE 06-23-95

TASK NO: 04306

ICF DWG NO: 2AREE36A

FIGURE 3-4

ABERDEEN PROVING GROUND

PRIOR AND PROPOSED SAMPLING LOCATIONS FOR AREES 3 AND 6A

Table 3-3
Detected Concentrations of Analytes from Previous Investigations for AREE 2

Analyte	Landfill 2, No. 3/ 330802/ Surface Soil	Landfill 2, No. 6/ 330805/ Surface Soil	Landfill 2, No. 7/ 384102/ Surface Water	Landfill 2, MW-2/ 384101/ Groundwater	Landfill 2, MW-2/ Groundwater	Landfill 2, MW-3/ Groundwater	Landfill 2/ 02SE01/ Sediment	Landfill 2/ 02SE02/ Sediment	Landfill 4/ 02SE04/ Sediment
PCB-1016	2	200	ND	ND	NA	NA	ND	ND	ND
PCB-1260	ND	3	ND	ND	NA	NA	0.14	0.13	0.07
PCB-1221	NA	NA	NA	NA	7[1]	7[1]	NA	NA	NA
Di-n-octyl phthalate	NA	NA	24	28	NA	NA	NA	NA	NA
Bis (2-ethylhexyl) phthalate	NA	NA	20	25	NA	NA	NA	NA	NA

[1] Data were suspected to be inaccurate because results could not be confirmed by later investigations.
All units for aqueous samples are in micrograms per liter (μg/L).
All units for solid samples are in micrograms per gram (μg/g).
PCB - Polychlorinated biphenyl
AREE- Area Requiring Environmental Evaluation
ND - Not Detected
NA - Not Analyzed

Table 3-4
Detected Concentrations of Analytes from Previous Investigations for AREE 5

Analyte	05EX01/ 05EX0101/ Excavated Soil	05EX02/ 05EX0201/ Excavated Soil	05EX03/ 05EX0301/ Excavated Soil	05DP01/ 05DP0101/ Groundwater	05DP03/ 05DP0301/ Groundwater	05DP03/ 05DP0302/ Groundwater[1]
4,4-DDD	0.0199 K	ND	ND	ND	ND	ND
4,4-DDE	0.0403 K	0.0272 K	ND	ND	ND	ND
4,4-DDT	ND	0.0306 K	ND	ND	ND	ND
Acetone	ND	ND	ND	ND	17	20
Alpha-chlordane	ND	0.043 K	ND	ND	ND	ND
Dieldrin	ND	0.0101 K	ND	ND	ND	ND
PCB-1254	0.33	ND	ND	0.14	ND	ND
PCB-1260	ND	ND	0.14	ND	ND	ND
TPH[2]	35.1	27.2	19.4	ND	ND	ND

All units for aqueous samples are in micrograms per liter (μg/L).
Units for solid samples (with the exception of TPH) are in micrograms per gram (μg/g).

[1] Replicate
[2] - Concentrations of TPH reported in milligrams per kilogram (mg/kg).
PCB - Polychlorinated biphenyl
TPH - Total Petroleum Hydrocarbon
ND - Not Detected
NA - Not Analyzed
K - Missed holding times for extraction and preparation.

respectively, in the groundwater sample collected from MW-2 (ESE, 1985). Di-n-octylphthalate and bis(2-ethylhexyl)phthalate were detected at concentrations of 24 μg/L and 20 μg/L, respectively, in a surface water sample (Landfill 2, No. 7, 384102) collected from AREE 2 (ESE, 1985). PCBs were detected in 3 sediment samples collected during the 1993 SI downgradient of AREE 2 at concentrations of 0.14 μg/g (02SE01), 0.13 μg/g (02SE02), and 0.07 μg/g (02SE04). It should be noted that sediment sample 02SE04 is also located downgradient from AREE 5 (USAEC, 1995).

PCBs, TPH, and pesticides were detected in soil samples collected from AREE 5 at maximum concentrations of 0.33 μg/g (05EX0101), 35.1 mg/Kg (05EX0101), and 0.043 μg/g (05EX0201) respectively, and were collected during the same SI associated with AREE 2. PCB-1254 was detected in a groundwater sample collected from direct push sample 05DP0101 at a concentration of 0.14 μg/L (USAEC, 1995).

3.2.3.1 Groundwater/Subsurface Soil. Seven shallow soil boring/monitoring wells (one upgradient and 6 downgradient) located to encompass AREEs 2 and 5, will be drilled to identify potential source areas and the extent of PCB, TPH, and pesticide contamination in the soil. These borings will be completed as monitoring wells (MW-68 and MW-70 through MW-74, and MW-81) to investigate potential groundwater contamination. Proposed soil boring/monitoring well MW-71 will address the PCB contamination found at 05DP0101. and soil boring/monitoring well MW-68 will serve as an upgradient well due to the screen placement of existing well MW-1. The top of the screen of existing well MW-1 is below the water table, thereby rendering it unable to provide monitoring data for TPH. MW-81 will be located adjacent to existing monitoring wells MW-2 and MW-3 and completed such that the screens are placed to intercept light phase compounds, if present. In addition, 2 deep monitoring wells will be installed. MW-82 will be located adjacent to MW-2 (forming a well cluster with MW-81) to evaluate potential downward migration of PCBs in an area where PCBs have been detected in the past. MW-83 will be installed adjacent to prior sample 05DP0101 where PCBs were detected. Deep well MW-83 will form a well cluster with shallow monitoring well MW-71.

Five of the six existing monitoring wells (MW-1 through MW- 5) will be re-sampled for the RI. Monitoring well MW-6 will not be sampled due to a damaged well casing which could compromise the integrity of the sample. Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, and TAL metals, PAHs, PCTs, and TPH in order to further characterize groundwater within AREEs 2 and 5.

One soil boring (RISB-6) will be installed adjacent to the SI sample location (02SW04) where PCBs were detected. One soil boring will be drilled adjacent to former sediment sample 02SE01 to further evaluate potential subsurface soil contamination where PCBs were detected. This soil boring will be converted to a piezometer (PZ-12) for the site hydrologic model. Subsurface soil samples will analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH.

3.2.3.2 Surface Soil. Five surface soil samples (RISS5-9) will be collected within and around AREEs 2 and 5 to characterize the extent of surficial contamination. Soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, PCTs, and TPH.

3.2.3.3 Test Pits. One test pit (TP3) will be excavated in AREE 2 to delineate the extent of PCB contamination remaining on the site after the 1984 remedial action performed by Weston. One test pit (TP4) will be excavated in AREE 5 to characterize the site of a former disposal pit where metal debris is partially buried. Two soil samples will be collected from each test pit and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH.

3.2.4 AREE 3 - Former Dump No. 3

AREE 3 is approximately 100 ft by 25 ft and is located just east of the pond on the east side of Lake Drive (Weston, 1992). The burial of debris, such as wood, lead-coated wire, paper, and plastic, reportedly began in 1966 until it was covered with soil in 1973 (Weston, 1992).

During the 1993 SI, the location of the disposal area was confirmed. Direct push groundwater samples were collected from this AREE and acetone was detected in groundwater at a level of 18 μg/L (03DP02) (USAEC, 1995). The former sample locations from past investigations, as well as the proposed surface soil sample locations for this RI, are presented in Figure 3-4. Table 3-5 lists the maximum concentrations of analytes detected from past investigations.

3.2.4.1 Surface Soil. Three surface soil samples will be collected for site characterization (RISS 10-12). Soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, PAHs, and TAL metals.

3.2.4.2 Test Pits. Two test pits (TP13 and TP14) will be excavated in the former disposal area to characterize the site. Two soil samples will be collected from each test pit and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, and TAL metals.

3.2.5 AREE 4 - Former Dump No. 4

AREE 4 is a former dump site where debris, such as wire, wood, concrete, pipe insulation, and empty oil drums, were dumped from the late 1950s until 1973 when the dump was covered with dirt (Weston, 1992). Geophysical surveys were conducted by USAEC during the SI performed in 1993, as well as trenching, soil sampling, and direct push groundwater sampling. The sample locations from past investigations are presented in Figure 3-3. PCBs and TPH were detected at concentrations of 0.85 μg/g and 220.7 mg/kg in sample 04EX0101 (collected from a depth of 5.5 feet in a trench excavated to evaluate a geophysical anomaly at AREE 4). Several other geophysical anomalies were identified during the SI but were not investigated via trenching (USAEC, 1995). The maximum concentrations of analytes detected from past investigations are presented in Table 3-5. The proposed sample locations for soil boring/monitoring wells, surface soil samples and test pit locations for this RI are presented in Figure 3-3 and are discussed in the following section.

3.2.5.1 Groundwater/Subsurface Soil. Three soil boring/monitoring wells, one upgradient (MW-64), and two downgradient (MW-66 and MW-67) will be installed around the previously-trenched area. These wells are designed to evaluate upgradient groundwater quality and the extent of subsurface soil and groundwater contamination in downgradient areas associated with this AREE. Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, PCTs, and TPH. Subsurface soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH.

3.2.5.2 Test Pits. Eight geophysical anomalies previously-identified west of AREE 4 will be investigated. Test pits (TP5 through TP12) will be excavated at the previously identified geophysical anomalies to evaluate whether subsurface soil contamination is present. Test pits TP10 - TP12 will be excavated in the area between AREEs 6A and 4 along a dirt road where debris has been identified. Two soil samples will be collected from each test pit and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH.

3.2.5.3 Surface Soil. Four soil samples (RISS13-16) will be collected for site characterization to determine the extent of surficial contamination associated with AREE 4. Soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, PCTs, and TPH.

Table 3-5
Detected Concentrations of Analytes from Previous Investigations for AREEs 3 and 4

Analyte	03DP02/ Groundwater	04EX01/ 04EX0101/ Excavated Soil
4,4-DDD	ND	ND
4,4-DDE	ND	ND
4,4-DDT	ND	ND
Acetone	18	ND
Alpha-chlordane	ND	ND
Dieldrin	ND	ND
PCB-1254	ND	ND
PCB-1260	ND	0.85
TPH[1]	NA	220.7

All units for aqueous samples are in μg/L.
Units for solid samples (with the exception of TPH) are in μg/g.
[1] - Concentrations of TPH reported in mg/kg.
PCB - Polychlorinated biphenyl
TPH - Total Petroleum Hydrocarbon
ND - Not Detected
NA - Not Analyzed
K - Missed holding times for extraction and preparation.

3.2.6 AREE 6A - Former Dump 6A

AREE 6A is a former dump area located west of Deephole Point Road and south of Lake Drive. The dump was identified by ground scars and soil disturbances observed in aerial photographs. Metal debris has been observed protruding from the toe of the slope along the southwestern extent of this AREE. Soil samples were collected during the 1993 SI and analyzed for PCBs and pesticides. No PCBs or pesticides were detected (USAEC, 1995). The location of former sample locations from past investigations, as well as proposed soil boring/monitoring well, test pit excavations, and surface soil sample locations, are presented in Figure 3-4.

3.2.6.1 Groundwater/Subsurface Soil. Two soil borings/monitoring wells (MW-65 and MW-69) will be installed downgradient of AREE 6A. These wells are designed to evaluate downgradient groundwater quality and the extent of subsurface soil and groundwater contamination in downgradient areas associated with this AREE. It should be noted that MW-69 will be installed at the former sediment sample location 02SE02 (SI sample location for AREE 2, refer to Table 3-3) to investigate potential subsurface soil and groundwater contamination in this area. MW-69 is also downgradient of AREE 3. Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, PAHs, and TAL metals. Subsurface soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, and TAL metals.

3.2.6.2 Surface Soil. Seven surface soil samples (RISS17-23) will be collected for the RI to further characterize AREE 6A. Surface soil samples will be collected from areas where stressed vegetation has been identified. Soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, PAHs, and TAL metals.

3.2.6.3 Test Pits. Three test pits (TP15 through TP17) will be excavated across the former disposal area to characterize the site. Two soil samples will be collected from each test pit and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, and TAL metals. In addition, test pits TP10 - TP12 will be excavated along the dirt road adjacent to AREE 6A (refer to Section 3.2.5.2).

3.2.7 AREE 6B - Potential Dump

A geophysical survey was conducted in AREE 6B during the 1993 SI, with supplemental trenching and soil sampling. No debris was identified during trenching activities; therefore, no samples were collected. A supplemental investigation of the AREE was conducted and a soil boring was drilled and sampled. TPH was detected in soil samples collected from soil boring 06BH01 at depths of 0.5 to 1.5 feet bgs and 4.5 to 5.5 feet bgs at concentrations of 28 mg/kg and 61.4 mg/kg, respectively (USAEC, 1995). The source or extent of TPH contamination is not known at this time. The former sample locations from past investigations, as well as the proposed soil boring/monitoring well locations, test pit excavations, and surface soil sample locations for this RI, are presented in Figure 3-2.

3.2.7.1 Groundwater/Subsurface Soil. A soil boring/monitoring well (MW-60) will be installed upgradient of this AREE (which is also upgradient of AREE 7) to evaluate groundwater quality. Downgradient soil boring/monitoring well, MW-75, (also discussed in Section 3.2.1) will be installed downgradient from AREEs 6B, and 7 to evaluate groundwater quality and subsurface soil conditions in this area. Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH to evaluate the water quality in the vicinity of the AREE and prior to off-site discharge. Subsurface soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and TPH

3.2.7.2 Surface Soil. Two surface soil samples will be collected for site characterization (RISS24 and RISS25) and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH.

3.2.7.3 Test Pits. Two test pits (TP18 and TP19) will be excavated to investigate and characterize metal debris found in an area west of Deephole Point Road in this AREE. An additional test pit (TP20) will be excavated east of Deephole Point Road to investigate a suspected disposal area where TPH was detected during the 1993 SI. Two soil samples will be collected from each test pit and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and TPH.

3.2.8 AREE No. 7 - Former Pistol Range

AREE 7 is a former pistol range located at the intersection of Deephole Point Road and Shady Lane. The range was used for small arms firing on a semi-annual basis during the 1970s. The AREE was investigated during the 1993 SI. Surface soil and subsurface soil samples were collected and analyzed for metals. One spent bullet was found in soil boring 07BH01 at a depth of 1.5 feet bgs and one shell casing was found in borehole 07BH04 at an approximate depth of 1 foot bgs (USAEC, 1995). The former sample locations from past investigations as well as the proposed monitoring well locations, and surface soil sample locations for this RI are presented on Figure 3-2.

3.2.8.1 Groundwater/Subsurface Soil. One soil boring/monitoring well (MW-59) will be installed in AREE 7 and soil samples will be collected to evaluate the extent of subsurface soil and groundwater contamination. In addition to monitoring well MW-59, monitoring well MW-75 (to be installed downgradient of AREEs 6B and 7) will be used to evaluate groundwater quality and the extent of groundwater contamination downgradient of this AREE (MW-75 will also be used to evaluate groundwater quality downgradient of AREE 6B, as previously discussed). Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH. Subsurface soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH. Groundwater and subsurface soil samples collected from MW-75 will also be analyzed for PCTs.

3.3 AREES ASSOCIATED WITH THE MAIN FACILITY COMPOUND

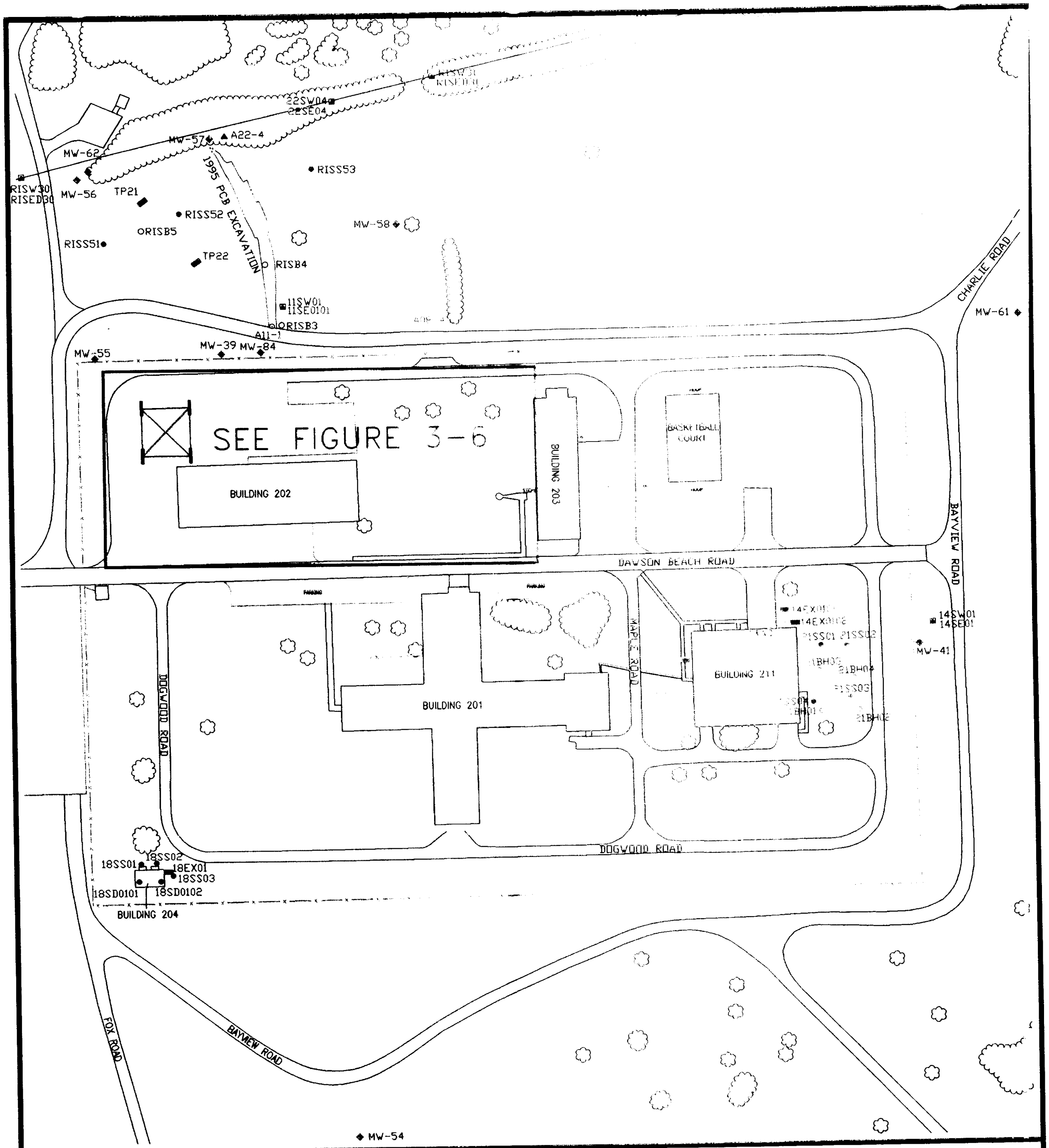
The AREEs associated with the main facility compound outlined in the USAEC Task Order for this RI are discussed in the following sections. AREEs to be investigated for the RI are identified along with the rationale for additional sampling and analysis. AREEs not to be investigated have been discussed in the workplan and are not discussed further in this document. Most of the USTs are being or have been investigated. Water-level measurements will be collected from the existing monitoring wells installed from previous investigations to use for the facility hydrogeologic model.

3.3.1 Background Location Rationale

An upgradient background soil boring/monitoring well (MW-54) will be installed on the south side of Bayview Road to assess background subsurface soil and groundwater conditions in this area. The proposed background monitoring well location is presented in Figure 3-5. Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, PCTs, and TPH. Subsurface soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH.

3.3.2 WRF Compound Downgradient Location

In addition to the monitoring wells described in the following sections, a soil boring/monitoring well (MW-61) will be installed in a downgradient location at the corner of the Bayview Road and Charlie Road. The proposed downgradient monitoring well location is presented on Figure 3-5. This area receives surface water runoff from the northeast portion of the compound. This monitoring well will be installed to determine whether groundwater or subsurface soils have been impacted by run off or other potential upgradient sources. The groundwater samples collected from MW-61 will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, PAHs, and TPH. Subsurface soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH.



LEGEND

	TREELINE
	ROADS
	EXCAVATION
	FENCE LINE
	TOPOGRAPHIC CONTOUR (CONTOUR INTERVAL 2 FEET)
MW-35	PRIOR MONITORING WELL LOCATION
MW-59	PROPOSED MONITORING WELL LOCATION
12BH02	PRIOR SOIL BORING LOCATION
RISB2	PROPOSED SOIL BORING LOCATION
11SW01 11SE01	PRIOR SURFACE WATER/SEDIMENT LOCATION
RISW31 RISED31	PROPOSED SURFACE WATER/SEDIMENT LOCATION
08SS0102	PRIOR SURFACE SOIL LOCATION
RISS53	PROPOSED SURFACE SOIL LOCATION
A22-4	PRIOR SEDIMENT LOCATION
12EX0102	PRIOR EXCAVATION LOCATION
TP22	PROPOSED EXCAVATION LOCATION
23AQ01	PRIOR AQUEOUS SAMPLE LOCATION

N

100 0 100

SCALE FEET

US ARMY ENVIRONMENTAL CENTER

CONTRACT NO. DACA31-94-D-0064

FIGURE 3-5

WOODBRIDGE RESEARCH FACILITY

ICF KAISER ENGINEERS

1301 Continental Drive
Suite 101
Abingdon, Maryland 21009
(410) 612-6350

PRIOR AND PROPOSED SAMPLING LOCATIONS FOR SELECTED AREAS IN WRF MAIN FACILITY COMPOUND

PREPARED KDM
CHECKED JC
DATE 07-10-95
TASK NO: 68220
ICF DWG NO: COMPOUND

3.3.3 AREES in the Vicinity of Building 202

The AREEs in the vicinity of Building 202 include AREEs 11, (Building 202 Drainage Devices), AREE 8, (UST Leaks), AREE 12, (Former Drum Storage Area), 17 (Petroleum Spill Area), 23 b (Former 1,000 Gallon UST), 24 a (Existing 2,000 Gallon Diesel UST),b (Existing 1,000 Gallon Gas UST), and portions of AREE 22 (Drainage Ditch). Investigations have been performed for all these AREEs except AREE 17, and the results are discussed below. AREE 17 is the site of a former hydraulic oil spill that occurred when approximately 100 to 150 gallons of No. 2 hydraulic oil leaked on the soil. Sample locations from previous investigations are presented in Figure 3-5.

Several uncontrolled releases of petroleum products have been reported in the vicinity and PCBs have been detected. Limited excavation around the oil/water separator (AREE 11) was performed during the 1993 SI. Soil samples collected from the excavation contained low levels of SVOCs, and TPH ranging in concentrations from 145 mg/kg (11EX0103) to 4937 mg/kg (11EX0102). The separator outfall was sampled and SVOCs, chlorobenzene and PCBs were detected. A sediment sample(11SE0101) was collected from the outfall area associated with AREE 11. The PCB level at the outfall was 1170 $\mu g/g$ (USAEC, 1995). A removal action was initiated to remediate this area. The oil/water separator, washrack, and soils around the excavated pits and contaminated soils along a ditch leading to the outfall area were removed in 1995. Portions of the ditch excavation are presented on Figure 3-5. During the removal action excavation, a water-bearing sand lens was encountered which had a visible oil sheen. The water was sampled for PCBs and TPH. PCBs were detected at 6.4 $\mu g/L$ and TPH estimated at 220 $\mu g/L$ (U.S. Army Corps of Engineers, Oklahoma District). A pre-excavation soil sample was collected from the trench area and was analyzed for PCBs. PCBs were detected as high as 16,000 $\mu g/g$ (Personal Communication, Todd Waltemyer, WRF). Soil samples were collected from the excavation for the removal action and PCBs were detected in the remaining soils at levels as high as 210 ppm from a sample collected from the sidewall of the excavation (USACE, 1995). Hydropunch® samples were collected in downgradient locations to determine the extent of TPH contamination. The Hydropunch® sample locations are not presented on Figure 3-6 because the exact locations are not known. TPH was detected in all downgradient locations investigated including the drainage ditch (AREE 22). The extent of the contamination has not been determined. The extent of the TPH contamination and the sand lens identified during the removal action will be investigated during the RI/FS activities. The suspected source areas for the TPH contamination are the former USTs located on the east side of Building 202 (AREE 23b), the former washrack area, the UST located on the north side of Building 202 (AREE 24a,b) and possibly from the UST located on the east side of Building 203 (AREE24c). The likely PCB source areas are the former oil/water separator and the nearby washrack. Table 3-6 lists the maximum concentrations of analytes detected from past investigations for AREEs 11, 22, and 23b.

AREE 8 was investigated during the 1993 SI. The former sample locations from past investigations are presented in Figure 3-5. TPH was detected at a maximum concentration of 2166 mg/Kg in subsurface soil sample 08BH3204 (MW-32 location in Figure 3-6) and was also detected in all other soil samples collected (USAEC, 1995). Subsequent to the soil samples collected during the SI, monitoring wells were installed as part of a Site Characterization Program for leaking USTs for VDEQ. TPH was detected in the groundwater sample collected from MW-32 at a concentration of 3.08 $\mu g/L$ (USAEC, 1995a). Water-level measurements will be collected for the hydrogeologic model of the facility. A summary of subsurface soil and groundwater sampling results is presented in Table 3-7.

AREE 12 is a former drum storage area located adjacent to the north side of Building 202. Composite surface soil samples were collected from soils immediately below the paved area at this location and analyzed for TPH, VOCs, and SVOCs. Former sample locations are presented on Figure 3-6. Soil borings were drilled and subsurface soil samples were collected from depths ranging from 1 to 8 feet bgs. Subsurface soil samples were analyzed for VOCs, SVOCs, TPH, PCBs, pesticides and TAL metals. Acetone, 2-butanone, and TPH at maximum concentrations of 0.100 $\mu g/g$, 0.012 $\mu g/g$, and 66.3 mg/kg,

Table 3-6

Detected Concentrations of Analytes from Previous Investigations for AREEs in the Vicinity of Building 202 (AREEs 11, 17, 22, and 23b, 24a, and 24b)

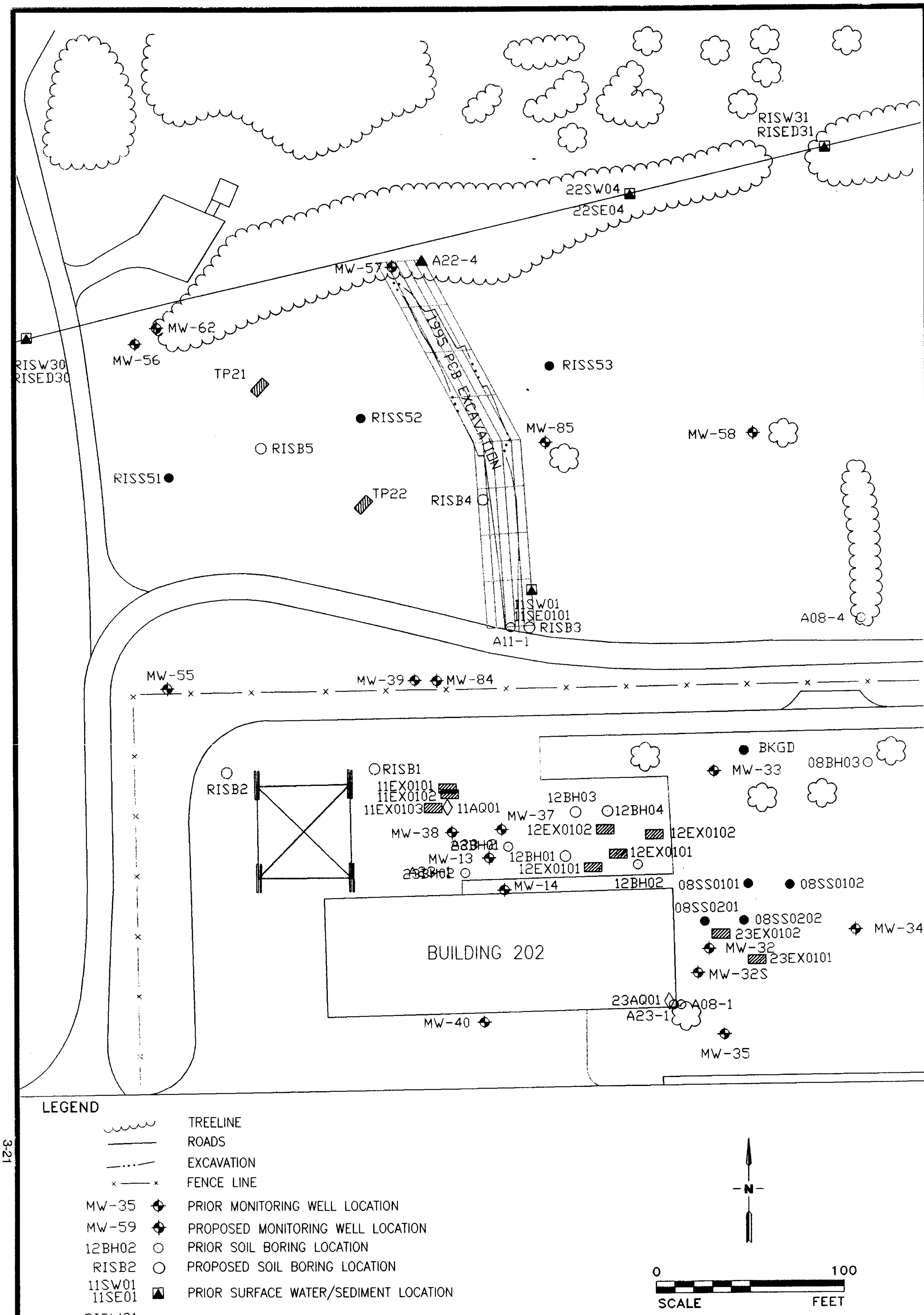
Analyte	11EX0101 Soil	11EX0102 Soil	11EX0103 Soil	11SE0101 Sediment	22SE01 Sediment	22SE02 Sediment
Bis(2-ethylhexyl) phthalate	0.28	ND	ND	ND	ND	ND
Phenanthrene	0.20	ND	ND	ND	ND	ND
Fluorene	0.45	ND	ND	0.22	ND	ND
Ethylbenzene	ND	ND	ND	0.0042	ND	ND
2-Butanone	ND	ND	ND	0.0096	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	260	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	8.6	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	39	ND	ND
Chlorobenzene	ND	ND	ND	1.6	ND	ND
PCB-1260	ND	ND	ND	1170	ND	ND
TPH[1]	4250	4937	145	ND	18	14

All units for aqueous samples are in $\mu g/L$.
All units for solid samples (with the exception of TPH) are in $\mu g/g$.
[1] Concentrations of TPH reported in mg/kg.
PCB - Polychlorinated biphenyl
AREE - Area Requiring Environmental Evaluation
ND - Not Detected

Table 3-6 (Continued)
Detected Concentrations of Analytes from Previous Investigations for AREEs in the Vicinity of Building 202
(AREEs 11, 17, 22, and 23b, 24a, and 24b)

Analyte	23BH0102 (Weston) Soil	23BH0202 (Weston) Soil	23EX0101 Soil	23EX0102 Soil	23EX0201 Soil
Bis(2-ethylhexyl)phthalate	ND	ND	NA	NA	NA
Phenanthrene	ND	ND	NA	NA	NA
Fluorene	ND	ND	NA	NA	NA
Ethylbenzene	ND	ND	NA	NA	NA
2-Butanone	ND	ND	NA	NA	NA
1,2,4-Trichlorobenzene	ND	ND	NA	NA	NA
1,2-Dichlorobenzene	ND	ND	NA	NA	NA
1,4-Dichlorobenzene	ND	ND	NA	NA	NA
Chlorobenzene	ND	ND	NA	NA	NA
PCB-1260	ND	ND	NA	NA	NA
TPH[1]	353	75	209	302	30

All units for solid samples (with the exception of TPH) are in $\mu g/g$.
[1] Concentrations of TPH reported in mg/kg.
PCB - Polychlorinated biphenyl
AREE - Area Requiring Environmental Evaluation
ND - Not Detected
NA - Not Analyzed



US ARMY ENVIRONMENTAL CENTER

CONTRACT NO. DACA31-94-D-0064	FIGURE 3-6 WOODBRIDGE RESEARCH FACILITY
ICF KAISER ENGINEERS 1301 Continental Drive Suite 101 Abingdon, Maryland 21009 (410) 612-6350	PRIOR AND PROPOSED SAMPLING LOCATIONS FOR AREES ASSOCIATED WITH BUILDING 202
PREPARED KDM / TASK NO: 66220	
CHECKED JC / ICF DWG NO: COMPOUN3	
DATE 07-11-95	

Table 3-7
Detected Concentrations of Analytes from Previous Investigations for AREE 8

Sample Number	Location Number	Sampling Interval (feet bgs)	Total Petroleum Hydrocarbons (mg/kg)
Subsurface Soil			
08BH3204	BH32D	6-8	2166
08BH3206	BH32D	10-12	149
08BH0303	A08-3	4-6	109
Surface Soil			
8SS0101		NA	14
8SS0201		NA	42
Groundwater (μg/L)			
08MW3201	MW32D	NA	3.08
08MW3212[(1)]	MW32S	NA	0.653

bgs - below ground surface
NA - Not Applicable
[(1)] - replicate

respectively, were detected in the shallow composite soil samples (12EX0101 and 12EX0102). Di-n-octylphthalate was detected at a maximum concentration of 0.270 μg/g in one of the subsurface soil samples collected from the soil borings (USAEC, 1995). A summary of the detected compounds for the subsurface soil samples is presented in Table 3-8.

The proposed monitoring well locations, soil boring locations, and surface soil sample locations for this RI are presented on Figure 3-5. The rationale for the proposed sampling locations is discussed below.

3.3.3.1 Groundwater/Subsurface Soil. Five shallow soil boring/monitoring wells (MW-55 - MW-58 and MW-85) and two deep monitoring wells (MW-62 and MW-84) will be installed in downgradient locations from the suspected source areas to evaluate the extent of subsurface soil and groundwater contamination. MW-55 is located in an area where stressed vegetation has been observed in an area which receives surface water runoff and is also downgradient from the former Oil/Water Separator. As previously discussed, a sand lens, which is believed to trend northwest from the Oil/Water Separator was encountered during the removal action. Shallow monitoring well MW-56 and deep monitoring well MW-62 will be installed in a downgradient location to intercept the sand lens. Groundwater samples collected from wells MW-56 and MW-62 will be analyzed to evaluate whether upper and lower groundwater zones are contaminated from the migration of TPH and PCBs detected in this area. Monitoring wells MW-57 and MW-58 are located adjacent to the drainage ditch to evaluate groundwater quality prior to potential discharge to the drainage ditch. Existing monitoring wells MW-37, MW-38, and MW-39, which were installed as part of a Phase II Site Characterization, will be sampled for this RI to investigate groundwater quality downgradient of the Drum Storage Area (AREE 12) and AREEs 11 and 23. In addition, a deep monitoring well will be clustered with existing well MW-39 to evaluate water quality just downgradient from the former washrack area.

Water level measurements will be collected from all existing wells in this area to extend the data base for the hydrogeologic model. In addition, 2 soil borings (RISB1 and RISB2) will be drilled in the paved area west of the oil/water separator to evaluate the extent of subsurface soil contamination in this area and to characterize and delineate the extent of contamination in AREE 17. AREE 17 is also being sampled in the Phase II SSI.

Soil borings will be drilled to evaluate the extent of contamination in the area near the PCB removal action as follows: One soil boring (RISB3) will be drilled adjacent to the headwall along Locust Road where the culvert crosses under the road. Soil Boring RISB4 will be drilled adjacent to the sidewall of the PCB excavation ditch where the 210 ppm residual PCBs were detected. Soil Boring RISB5 will be drilled in the area between the PCB excavation ditch and monitoring wells MW-56 and MW-62 to evaluate potential subsurface soil contamination in that area. The locations of the soil borings are presented in Figure 3-5.

Existing monitoring wells MW-33, MW-34, and MW-35 (shown in Figure 3-6) will be sampled during the RI to evaluate groundwater quality downgradient of AREE 8. Existing monitoring wells MW-37 and MW-38 (shown in Figure 3-6) will be sampled during the RI to evaluate groundwater quality downgradient of AREE 12.

Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, PAHs, and TPH. Subsurface soil samples will also be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH. However, existing monitoring wells MW-37 and MW-38 will not be analyzed for PCTs.

3.3.3.2 Surface Soil. Three surface soil samples (RISS51 - RISS53) will be collected from this area, one on the east side of the PCB excavation ditch and two on the west side of the PCB excavation ditch. Surface soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH.

Table 3-8
Detected Concentrations ($\mu g/g$) of Analytes from Previous Investigations for AREE 12

Sample Number	Sample Depths (bgs)	Acetone	2-Butanone	Total Petroleum Hydrocarbon[1]	Di-n-octyl Phthalate
12EX0101	1.5	0.13500	0.02020	40.5	ND
12EX0102	1.5	0.09400	0.01280	66.3	ND
12BH0101	1	0.06900	0.00550	25.9	ND
12BH0201	1	0.08600	ND	ND	ND
12BH0203	5	ND	ND	ND	0.180
12BH0302	2	ND	ND	ND	0.250
12BH0305	8	ND	ND	ND	0.160
12BH0402	2	ND	ND	ND	0.270

ND - Not Detected
bgs - below ground surface
1 - Concentrations of TPH reported in mg/kg

3.3.4 AREE 14 - Oil/Water Separator

AREE 14 is an oil/water separator located adjacent to the north side of Building 211. Soil, sediment, and surface water samples were collected during the 1993 SI. TPH was detected in the subsurface soil samples and SVOCs were detected in surface water at the outfall for the oil/water separator (USAEC, 1995). The oil/water separator may be removed by late 1995. Sample locations from previous investigations are presented in Figure 3-5. Detected concentrations of analytes from previous investigations are presented in Table 3-9.

3.3.4.1 Groundwater. Existing monitoring well MW-41 will be sampled during the RI to evaluate groundwater quality downgradient of AREE 14. Groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH.

3.4 OTHER AREEs

AREEs not associated with the main facility compound that require further investigation for this RI are discussed in this section.

3.4.1 AREE 23a - Former UST (Building 101)

AREE 23a is the site of a former UST located adjacent to Building 101 (Figure 3-1). Drilling and sampling activities were performed in 1994 to characterize the site. TPH was detected in subsurface soil samples collected from one of the borings at concentrations of 10,700 mg/Kg (WRF-T101-2-4-6) and 12,000 mg/Kg (WRF-T101-2-7-9) collected at depths of 5 and 8 feet, respectively. TPH was detected in groundwater samples collected from newly-installed monitoring wells at concentrations of 0.2 mg/L and 0.15 mg/L (USACE, 1995a). These concentrations are below the Commonwealth of Virginia guideline of 1 mg/L for TPH in groundwater.

3.4.1.1 Subsurface Soil. One soil boring (RISB7) will be drilled in the paved area adjacent to the boring where TPH was detected in the subsurface soil. Subsurface soil samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH.

3.4.2 AREEs 25 & 35 - Antenna Field and Sewage Injection Areas, AREE 26 - Ethylene Glycol Area, and AREE 27 - Buried Wire

AREE 25 was identified by the 1994 SI Report as three sewage injection areas. These areas are located north of the main compound; west of the main compound along the drainage ditch; and east of Lake Drive, near the pond. An SI sampling program conducted in late-1993 found elevated levels of several metals (USAEC, 1995). Similar data was obtained in mid-1994 when this AREE was revisited as part of SSI No 1.

AREE 26 is located south of Building 306 and consists of buried rubber hoses filled with antifreeze. The antifreeze, which consists mostly of ethylene glycol, was put in neoprene rubber hoses which were cut at various lengths and then sealed. The hoses were then buried in the ground at depths of 1 to 3 feet. These were used as test materials for the detection of personnel intrusion security monitoring. The buried hoses were located and found to be intact during the SSI #1 sampling activities. Liquid samples of the contents of the hoses confirmed that the contents consisted of ethylene glycol. Soil samples were also collected.

Table 3-9
Detected Concentrations of Analytes from Previous Investigations for AREE 14

Sample ID Number	Bis(2-ethylhexyl)phthalate	Di-n-octylphthalate	Total Petroleum Hydrocarbon
Surface Water (mg/L)			
14SW01	1180	30	NA
Sediment (mg/kg)			
14SE01	ND	ND	51
14SE01 (1)	NA	NA	53
Excavated Soil (mg/kg)			
14EX0101	ND	ND	55
14EX0102	ND	ND	65

(1) - Replicate
ND - Not Detected
NA - Not Analyzed

AREE 27 is located at various locations throughout WRF. In the past, electrical cable was buried throughout the facility as part of an antenna system for a worldwide communication network. The antenna system was used until 1970. The buried cable typically consists of a copper conductor surrounded by a metal shield that was believed to contain copper, aluminum, or stainless steel, all encased in a plastic outer coating. Six soil samples were collected during the 1993 SI sampling program from this AREE. Elevated levels of metals were detected, but no PCBs (USAEC, 1995).

AREE 35 consists of an antenna fields located throughout WRF, which had PCB-contaminated transformers mounted to the antenna poles. These antenna fields are located adjacent to the western and southern fenceline at the main compound. It is possible that PCBs from these transformers may have contaminated the soil and groundwater.

3.4.2.1 Surface Soil. Twenty-five surface soil samples (RISS26 through RISS50) will be collected throughout these areas to identify potential sources of contamination. Surface soil locations are presented in Figure 3-1. Surface soils will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and PAHs. If PCBs are detected in a soil sample then the laboratory will be instructed to analyze the sample for PCTs.

3.4.3 AREE 38 - NVCC Study Area

AREE 38 is located on the southern boundary of the installation along the fence line adjacent to Marumsco Creek National Wildlife Refuge.

During July 1994, a class of students from Northern Virginia Community College (NVCC) and Garfield High School collected soil samples from the boundary of the wildlife refuge, including an area on WRF. The students of NVCC reportedly found mercury at a level of 350 μg/g; however, the analytical results have not yet been validated, and there are uncertainties associated with the accuracy of the mercury analytical data. The results of the Garfield High School soil samples were reported by a Gar-Field High School teacher as qualitative data. Recently, four soil samples were collected for the Supplemental Site Inspection (SSI) in the area near the NVCC samples. The samples were analyzed for mercury and the highest level detected was 0.05 μg/g (communication with Jeffrey Waugh, USAEC Project Officer). The SSI contractor also plans to collect additional samples for mercury analysis in the immediate vicinity of the NVCC samples.

Surface water and sediment samples will be collected as presented in Section 3.5, Surface Water and Sediment Sample Locations and Rationale.

3.5 SITE HYDROGEOLOGIC INVESTIGATION

Eleven piezometers will be installed around the site to aid in developing a site hydrogeologic model. Subsurface soil samples will be collected in the same manner as the soil borings for the monitoring wells. They will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and TPH.

3.6 SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS AND RATIONALE

This section provides a description of the locations of surface water and sediment samples to be collected during field operations at WRF. The goal of the surface water and sediment sampling program is to provide data for the RI and risk assessments.

3.6.1 Sample Location Rationale

The surface water bodies at WRF consist of drainage ditches, creeks, and a pond. Many of the creeks at WRF are tidally influenced and contain fresh water or water with very low salinity. Several of the creeks are inhabited by beavers (*Castor canadensis*) that have built dams. Above these dams, the tidal influence is reduced or prevented. The creeks and drainage ditches at WRF are generally shallow (less then 3 feet deep) with abundant emergent wetland vegetation. The surface water bodies around the facility (Marumsco Creek, Belmont Bay, and Occoquan Bay) are tidally influenced and range from fresh water to oligohaline (salinity to 5 parts per thousand (ppt)).

The surface water/sediment sample locations were selected based on the following considerations:

- The potential for the creek, ditch, or other surface water bodies to be impacted by the AREEs;
- The drainage patterns at WRF;
- The overlap of locations at which clam live-boxes were deployed; and
- Adequate spatial coverage of WRF and sufficient representation of reference conditions.

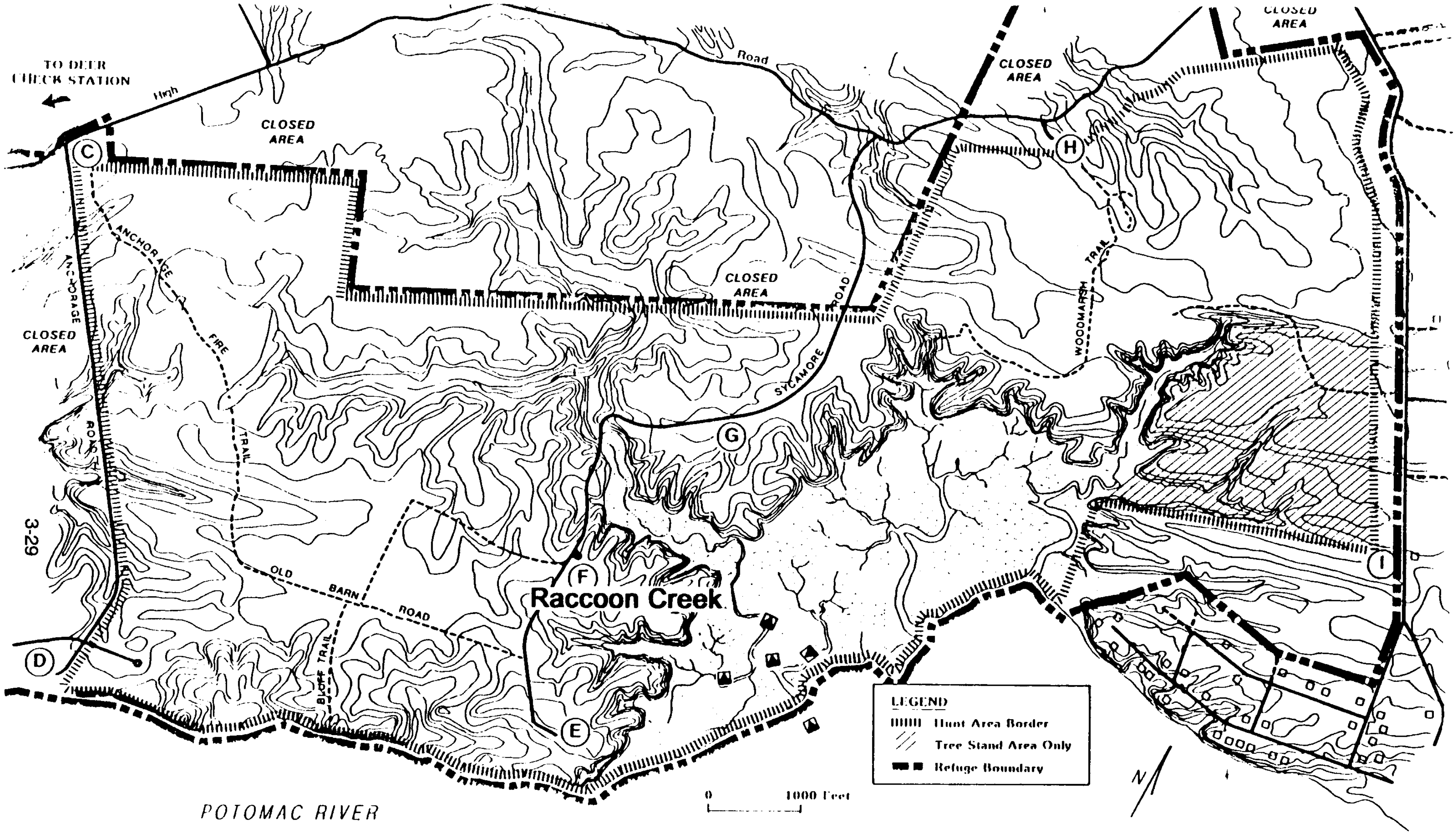
No sediment grain size data for WRF are available at this time. However, wherever possible fine-grained sediments will be collected for analysis. Therefore, though contaminants are frequently associated with fine-grained sediments, sample locations have been selected according to the criteria stated above. A total of 50 locations have been selected to be sampled for surface water and sediment during a field effort for the fall of 1995. This includes 45 samples from WRF and 5 reference samples. The locations of the surface water /sediment samples are presented in Figure 3-1 and the 5 reference samples are presented in Figure 3-7. It is anticipated that the 5 reference and 45 on-site sediment samples will include sediment samples of varying grain sizes and grain size percent compositions. Grain size and total organic carbon analyses will be performed on all sediment samples collected for the WRF investigation. A summary of the sediment and surface water sampling program is presented in Table 3-10.

The surface water and sediment sampling will be performed from a canoe, jon boat, or by reaching the location by foot. At each surface water sample location, a sediment sample will also be collected. The surface water sample will be collected prior to the sediment sample to eliminate the potential for introducing suspended sediments into the water column (and surface water sample) at the sample location.

At each sample location, a qualitative description of the location (e.g., dominant flora, habitat type, etc.) will be recorded in a field logbook. The position of each sample location will be recorded with a Global Positioning System (GPS) instrument.

3.6.2 Storm Event Sampling

Surface water run-off samples will be collected to characterize the potential for contaminant migration via surface water transport. The locations for storm water run-off sample collection will be determined during a storm event, therefore, specific locations have not yet been finalized. Potential locations have been identified during the RI scoping activities particularly in the former landfill areas. The proposed approach for finalizing these sample locations is to inspect the areas during a storm event to determine where run-off is occurring. Surface water flow will be measured during the initial inspection to evaluate the amount of flow in a given area. In addition, weather data will be obtained to compare the amount of flow to a measured rainfall event. The weather data will be obtained from the nearest weather station and a rain gauge on-site. It is anticipated that a storm event of at least one inch will be required in order to generate



PROPOSED SURFACE WATER/ SEDIMENT LOCATION

Figure 3-7
Location of Reference Surface Water and Sediment Samples

Table 3-10

WRF RI/FS Sediment and Surface Water Sampling Progran

Medium Sampled[1]	Number of Samples	Sample ID	Chemical Analyses[2]	Physical Testing	
					Background
Surface Water	5	RIBKSW1 - RIBKSW5	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, TPH, PCTs, PAHs.	Temp, pH, redox, D.O., cond. salinity	5 background surface water and sediment samples will be collected f
Sediment	5	RIBKSED1 - RIBKSED5		All samples will be analyzed for TOC and Grain size distribution.	
					Marumsco Creek
Surface Water	8	RISW1, 2, 5, 6, 13, 19, 20, 21.	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, TPH, PCTs	Temp, pH, redox, D.O., cond. salinity	Ten surface water and ten sediment samples will be collected in Maru are 1, 2, 3, 4, 5, 6a, and 6b. Other sites in the Marumsco Creek wate
Sediment	8	RISED1, 2, 5, 6, 13, 19, 20, 21.		TOC & Grain size distribution	

Medium Sampled	Number of Samples		Chemical Analyses	Physical Testing	
					Drainage Creek Between the Pond and Marumsco Creek
Surface Water	3	RISW10, 11, 12	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, TPH, PCTs, PAHs.	Temp, pH, redox, D.O., cond. salinity	Three surface water and three sediment samples will be collected fron 3, 4, 5, and 6a.
Sediment	3	RISED10, 11, 12		All samples will be analyzed for TOC and Grain size distribution.	
					The Pond
Surface Water	3	RISW7, 8, 9.	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, TPH, PCTs	Temp, pH, redox, D.O., cond. salinity	Three surface water and three sediment samples will be collected fron
Sediment	3	RISED7, 8, 9.		TOC & Grain size distribution	

[1] Forty-five surface water and sediment samples will be collected site wide. These samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, PAHs and TPH.

[2] Upon collection, groundwater samples shall be preserved as follows: VOCs pH < 2 with HCl; TAL metals pH < 2 with HNO_3; CN^- pH> 12 with NaOH.

ble 3-10
iurface Water Sampling Program

Rationale
ound
diment samples will be collected from Raccoon Creek on Mason Neck National Wildlife Refuge.
Creek
samples will be collected in Marumsco Creek to address the potential for contamination from WRF. The AREES in the Marumsco Creek watershed sites in the Marumsco Creek watershed include a pistol range and a sewage sludge injection field.

Rationale
Pond and Marumsco Creek
ent samples will be collected from the creek that drains the area below the pond and leads to Marumsco Creek. This creek runs between AREES 2,
nd
ent samples will be collected from the pond.

L metals, PCTs, PAHs and TPH. Sediment samples will also be tested for TOC and Grain size distribution.

Table 3-10 (Continued)
WRF RI/FS Sediment and Surface Water Sampling

Medium Sampled[1]	Number of Samples		Chemical Analyses[2]	Physical Testing	
					Western WRF Creek
Surface Water	17	RISW25 - RISW38, 40, 41, 42.	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, TPH, PCTs, PAHs.	Temp, pH, redox, D.O., cond. salinity	Three surface water and three sediment samples will be colle that drains the western portion of WRF. A field test facility an
Sediment	17	RISED25 - RISED38, 40, 41, 42.		All samples will be analyzed for TOC and Grain size distribution.	
					Occoquan Bay
Surface Water	8	RISW3, 14, 15, 16, 17, 18, 24, 39.	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, TPH, PCTs, PAHs.	Temp, pH, redox, D.O., cond. salinity	Eight surface water and eight sediment samples will be collec Bay locations from AREEs 1, 6B, and 7.
Sediment	8	RISED3, 14, 15, 16, 17, 18, 24, 39.		All samples will be analyzed for TOC and Grain size distribution.	
					Southern Drainage Creeks
Surface Water	3	RISW4, 22, 23.	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, TPH, PCTs, PAHs.	Temp, pH, redox, D.O., cond. salinity	Three surface water and sediment samples will be collected fr
Sediment	3	RISED4, 22, 23.		All samples will be analyzed for TOC and Grain size distribution.	
					Northern WRF Creek
Surface Water	3	RISW43, 44, 45	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, TPH, PCTs	Temp, pH, redox, D.O., cond. salinity	Three surface water and three sediment samples will be collec ditch itself and one sediment/surface water sample will be coll ditch.
Sediment	3	RISED43, 44, 45		TOC & Grain size distribution	

1 Forty-five surface water and sediment samples will be collected site wide. These samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, PAHs and

2 Upon collection, groundwater samples shall be preserved as follows: VOCs pH < 2 with HCl; TAL metals pH < 2 with HNO_3; CN^- pH> 12 with NaOH.

0 (Continued)
urface Water Sampling Program

Rationale
F Creek
ent samples will be collected from the creek that runs through the western portion of WRF. This creek exists within an extensive wetland complex IF. A field test facility and sewage sludge injection site are within the drainage of this creek.
ı Bay
·nt samples will be collected from Occoquan Bay. The proposed surface water and sediment sample locations are upgradient and downgradient 7.
ıge Creeks
mples will be collected from the ditches which drain the southern portion of the facility east of AREE 1.
F Creek
∶nt samples will be collected from the ditch that drains the northern portion of WRF. Two sediment/surface water samples will be collected from the water sample will be collected from Belmont Bay near the mouth of the creek. A field test area and an ethylene glycol filled hose area drain to this

metals, PCTs, PAHs and TPH. Sediment samples will also be tested for TOC and Grain size distribution.

enough run-off to collect a sample. Once the initial locations have been finalized, based on the above mentioned scoping activities, the sample collection points will be submitted for approval. After sample locations points have been approved, surface water samples will be collected during a storm event of similar or greater magnitude than the initial inspection storm event. The position of each sample location will be recorded at the time of sample collection with a GPS instrument.

Table 3-1

WRF RI/FS Groundwater, Surface And Subsurface Sa

Medium Sampled[1]	Number of Samples	Sample IDs	Chemical Analyses[2]	Physical Testing	
					Background
Surface Soil	5	RIBK1-RIBK5	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, TPH, PCTs, PAHs (surface soil and groundwater).	NA	5 background surface soil samples will be collecte
Subsurface Soil	9	MW-52, 53, 54 (3 samples/boring)		1 sample/boring will be analyzed TOC, Atterberg limits, USCS, Grain size distribution,and percent moisture.	3 soil borings will be drilled and completed as mo completed as monitoring wells. Two soil borings/r 35 feet below ground surface and 75 feet below g on the northwest side of WRF and completed to a Inner Perimeter Road to assess background subsu thereafter until total depth is reached. Total depth for deep well boring. 3 samples will be selected a table; and one sample from each boring will be se
Groundwater	8[3]	Shallow wells: MW-52, 53, 54 Deep well: MW-63		Temp, pH, redox, D.O., cond. salinity	
					Downgradient Locations From Former Dump
Subsurface soil	6	MW-75, 76 (3 samples/boring)	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, TPH, PCTs.	1 sample/boring will be analyzed TOC, Atterberg limits, USCS, Grain size distribution,and percent moisture.	Two monitoring wells (MW-75, and MW-76) will be samples will be collected from 0-2 ft bgs, 5-7 ft bg table for well borings. 3 samples will be selected table; and one sample from each boring will be se
Groundwater	4[3]	MW-75, 76	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, TPH, PCTs and PAHs.	Temp, pH, redox, D.O., cond. salinity	

[1] Forty-five surface water and sediment samples will be collected site wide. These samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, PAHs .

[2] Upon collection, groundwater samples shall be preserved as follows: VOCs pH < 2 with HCl; TAL metals pH < 2 with NHO_3; CN^- pH> 12 with NaOH.

[3] Total number of samples includes two rounds of groundwater samples collected a minimum of 2 months apart.

ıble 3-1
:e And Subsurface Sampling Program

Rationale
:kground
ıamples will be collected from 0 to 6-inches bgs.
and completed as monitoring wells to access site background subsurface soil characteristics and groundwater quality. The background borings will be ɜlls. Two soil borings/monitoring wells, MW-53 and MW-63, will be drilled along the northern boundary of WRF. The proposed total depths of these wells are :e and 75 feet below ground surface, respectively. Deep well boring MW-63 will not split-spooned sampled. 1 boring/monitoring well, MW-52, will be drilled ꞫF and completed to approximately 35 feet below ground surface. An upgradient background monitoring well (MW-54) will be installed on the south side of ıess background subsurface soil and groundwater conditions in this area. Split-spoon samples will be collected from 0-2 ft bgs, 5-7 ft bgs and every 5 ft ; reached. Total depth will be the water table for soil borings and 7 feet below the water table for shallow well borings and 10 feet below the confining unit ıples will be selected and sent to the laboratory as follows: one sample from the 0 to 2 ft below ground surface (bgs); one sample at the top of the water each boring will be selected based on obvious soil staining or elevated PID reading.
s From Former Dump Areas
'5, and MW-76) will be installed in downgradient locations from the former dump areas to evaluate groundwater quality prior to off-site flow. Split-spoon ›m 0-2 ft bgs, 5-7 ft bgs and every 5 ft thereafter until total depth is reached. Total depth will be the water table for soil borings and 7 feet below the water nples will be selected and sent to the laboratory as follows: one sample from the 0 to 2 ft below ground surface (bgs); one sample at the top of the water each boring will be selected based on obvious soil staining or elevated PID reading.

. metals, PCTs, PAHs and TPH. Sediment samples will also be tested for TOC and Grain size distribution

Table 3-1 (Continued)
WRF RI/FS Groundwater, Surface And Subsurface Samp

Medium Sampled[1]	Number of Samples	Sample IDs	Chemical Analyses[2]	Physical Testing	
					AREE 1
Surface Soil	4	RISS1-4	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, PCTs and PAHs (groundwater only).	NA	4 soil samples will collected from the 0 to 6-inch depth interval for sit
Test Pits	4	TP1 and TP2 (2 samples/test pit)		NA	Two test pits (TP1 and TP2) will be excavated downgradient from the extent of PCB contamination. Two soil samples will be collected fron
Subsurface Soil	12	MW-77,78,79,80. (3 samples/ boring)		1 sample/boring will be analyzed for TOC, Atterberg limits, USCS, Grain size distribution,and percent moisture.	4 soil borings will be drilled and samples collected to further charact total depth is reached. Total depth will be the water table for soil bo sample from the 0 to 2 ft below ground surface (bgs); one sample at reading.
Groundwater	20^3	New Wells: MW-77,78,79,80. Existing Wells: MW-7,8,9,10,11,12		Temp, pH, redox, D.O., cond. salinity	Four downgradient soil borings completed as monitoring wells will be contamination and are located to further characterize and evaluate su
					AREE 2 & 5
Surface Soil	5	RISS5-9	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, PCTs.	NA	5 soil samples will collected from the 0 to 6-inch depth interval for site

[1] Forty-five surface water and sediment samples will be collected site wide. These samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, PAHs and T pH, redox, dissolved oxygen, conductivity, and salinity.

[2] Upon collection, groundwater samples shall be preserved as follows: VOCs pH < 2 with HCl; TAL metals pH < 2 with NHO_3; CN^- pH> 12 with NaOH.

[3] Total number of samples includes two rounds of groundwater samples collected a minimum of 2 months apart.

1 (Continued)

:e And Subsurface Sampling Program

Rationale
.REEE 1
5-inch depth interval for site characterization.
ıted downgradient from the two trenches (Trenches 20 and 21) previously excavated and sampled during the 1993 USAEC SI to determine the downgradient nples will be collected from each test pit. Each sample will be selected based on obvious soil staining or PID hit.
:ollected to further characterize subsurface soil contamination. Split-spoon samples will be collected from 0-2 ft bgs, 5-7 ft bgs and every 5 ft thereafter until the water table for soil borings and 7 feet below the water table for well borings. 3 samples will be selected and sent to the laboratory as follows: one face (bgs); one sample at the top of the water table; and one sample from each boring will be selected based on obvious soil staining or elevated PID
as monitoring wells will be drilled (MW-78, MW-79, and MW-80). The proposed locations are closer than the existing wells to the known area of PCB ıaracterize and evaluate subsurface soil and groundwater contamination in AREE 1. Existing wells (MW- 7 through MW- 12) will be sampled for the RI/FS.
:E 2 & 5
;-inch depth interval for site characterization.

. metals, PCTs, PAHs and TPH. Sediment samples will also be tested for TOC and Grain size distribution and surface water samples will measured for temperature,

Table 3-1 (Continued)
WRF RI/FS Groundwater, Surface And Subsurface Samp

Medium Sampled[1]	Number of Samples	Sample IDs	Chemical Analyses[2]	Physical Testing	
AREE 2 & 5 (Continued)					
Test Pits	4	TP3 and TP4 (2 samples/test pit)	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, PCTs, and TPH.	NA	One test pit (TP3) will be excavated in AREE 2 to delineate the exte excavated in AREE 5 to characterize the site of a former disposal pi
Subsurface Soil	30	MW-68, 69, 70, 71, 72, 73, 74, 81, RISB6, and PZ-12.		1 sample/boring will be analyzed for TOC, Atterberg limits, USCS, Grain size distribution,and percent moisture.	Seven shallow soil boring/monitoring wells (one upgradient and 6 dc and pesticide contamination in the soil. These borings will be compl additional monitoring well (MW-69) will be installed at the former sed area. Proposed soil boring/monitoring well MW-71 will address the f placement of existing well MW-1. The top of the screen of existing w to existing monitoring wells MW-2 and MW-3 and completed such th MW-82 will be located adjacent to MW-2 (forming a well cluster with installed adjacent to prior sample 05DP0101 where PCBs were dete ft bgs, 5-7 ft bgs and every 5 ft thereafter until total depth is reached and sent to the laboratory as follows: one sample from the 0 to 2 ft b obvious soil staining or elevated PID reading. These borings will be sediment sample location to investigate potential subsurface soil and boring (RISB5) will be installed adjacent to the SI sample location wh piezometer (PZ-12).
Piezometers	1	PZ-12.	NA	NA	
Groundwater	30[3]	New Shallow Wells: MW-68, 69, 70, 71, 72, 73, 74, 81. Deep wells:MW-82,83 Existing Wells: MW-1, 2, 3, 4, 5	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, PCTs, PAHs and TPH.	Temp, pH, redox, D.O., cond. salinity	
AREE 3					
Surface Soil	3	RISS10-12	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, PCTs, PAHs (surface soil only) and TPH.	NA	3 soil samples will be collected from the 0 to 6 inch depth interval an
Test Pit	2	TP13 and TP14. (2 samples/test pit).		NA	

[1] Forty-five surface water and sediment samples will be collected site wide. These samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, PAHs and temperature, pH, redox, dissolved oxygen, conductivity, and salinity.

[2] Upon collection, groundwater samples shall be preserved as follows: VOCs pH < 2 with HCl; TAL metals pH < 2 with NHO_3; CN^- pH> 12 with NaOH.

[3] Total number of samples includes two rounds of groundwater samples collected a minimum of 2 months apart.

(Continued)
And Subsurface Sampling Program

Rationale
(Continued)
2 to delineate the extent of PCB contamination remaining on the site after the 1984 remedial action performed by Weston. One test pit (TP4) will be e of a former disposal pit where metal debris is partially buried. Two soil samples will be collected from each test pit.
one upgradient and 6 downgradient) located to encompass AREEs 2 and 5, will be drilled to identify potential source areas and the extent of PCB, TPH, se borings will be completed as monitoring wells (MW-68 and MW-70 through MW-74, and MW-81) to investigate potential groundwater contamination. An stalled at the former sediment sample location 02SE02 (SI sample location) to investigate potential subsurface soil and groundwater contamination in this MW-71 will address the PCB contamination found at 05DP0101, and soil boring/monitoring well MW-68 will serve as an upgradient well due to the screen f the screen of existing well MW-1 is below the water table, thereby rendering it unable to provide monitoring data for TPH. MW-81 will be located adjacent and completed such that the screens are placed to intercept light phase compounds, if present. In addition, 2 deep monitoring wells will be installed. rming a well cluster with MW-81) to evaluate if PCBs have migrated downward in an area where PCBs have been detected in the past. MW-83 will be where PCBs were detected. Deep well MW-83 will form a well cluster with shallow monitoring well MW-71. Split-spoon samples will be collected from 0-2 til total depth is reached. Total depth will be the water table for soil borings and 7 feet below the water table for well borings. 3 samples will be selected mple from the 0 to 2 ft below ground surface (bgs); one sample at the top of the water table; and one sample from each boring will be selected based on). These borings will be completed as monitoring wells (MW-70 through MW-74). An additional monitoring well (MW-69) will be installed at the former ntial subsurface soil and groundwater contamination in this area. Existing monitoring wells (MW-1 through MW- 5) will be resampled for the RI. One soil he SI sample location where PCBs were detected in AREE2. One soil boring will be installed by prior sediment sample location 02SE01 and converted to
EE 3
6 inch depth interval and 2 test pits will be excavated in the disposal area at AREE 3.for site characterization.

metals, PCTs, PAHs and TPH. Sediment samples will also be tested for TOC and Grain size distribution and surface water samples will measured for

Table 3-1 (Continued)
WRF RI/FS Groundwater, Surface And Subsurface Sampl

Medium Sampled[1]	Number of Samples	Sample IDs	Chemical Analyses[2]	Physical Testing	
					AREE 4
Surface Soil	4	RISS13-16	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, PCTs, PAHs (surface soil and groundwater only), TPH.	NA	Four soil samples will collected from the 0 to 6-inch d
Test Pits	16	TP5-12 (2 samples/test pit)		NA	10 geophysical anomalies previously identified west o evaluate the potential for subsurface soil contaminatio PID hit.
Subsurface Soil	9	MW-64, 66, 67. (3 samples/boring)		1 sample/boring will be analyzed for TOC, Atterberg limits, USCS, Grain size distribution,and percent moisture.	3 monitoring wells (MW-64, and MW-66 and MW-67) wells are designed to evaluate the extent of subsurfac and every 5 ft thereafter until total depth is reached. sent to the laboratory as follows: one sample from the based on obvious soil staining or elevated PID readin
Groundwater	6[3]	MW-64, 66, 67.		Temp, pH, redox, D.O., cond. salinity	
					AREE 6A
Surface Soil	7	RISS17-23	TCL VOCs, SVOCs, pesticides/PCBs, TAL metals and PAHs (surface soil and groundwater only).	NA	7 soil samples will collected from the 0 to 6-inch deptl boring/monitoring well (MW-65) will be installed down contamination in downgradient areas associated with Total depth will be the water table for soil borings and the 0 to 2 ft below ground surface (bgs); one sample reading.
Test Pits	6	TP15, 16, and 17		NA	
Subsurface Soil	3	MW-65 (3 samples/boring)		1 sample/boring will be analyzed for TOC, Atterberg limits, USCS, Grain size distribution,and percent moisture.	
Groundwater	2[3]	MW-65		Temp, pH, redox, D.O., cond. salinity	

[1]Forty-five surface water and sediment samples will be collected site wide. These samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, PAHs and T

[2] Upon collection, groundwater samples shall be preserved as follows: VOCs pH < 2 with HCl; TAL metals pH < 2 with NHO_3; CN^- pH> 12 with NaOH.

[3] Total number of samples includes two rounds of groundwater samples collected a minimum of 2 months apart.

I (Continued)
e And Subsurface Sampling Program

Rationale
REE 4
ited from the 0 to 6-inch depth interval for site characterization.
ireviously identified west of AREE 4 will be investigated. Test pits (TP5 through TP12) will be excavated at the previously identified geophysical anomalies to bsurface soil contamination. 2 subsurface soil samples will be collected from each test pit. Each sample will be selected based on obvious soil staining or
and MW-66 and MW-67) will be installed around the previously trenched area, one upgradient (MW-64) and two downgradient (MW-66 and MW-67). These ate the extent of subsurface soil and groundwater contamination associated with this AREE. Split-spoon samples will be collected from 0-2 ft bgs, 5-7 ft bgs il total depth is reached. Total depth will be the water table for soil borings and 7 feet below the water table for well borings. 3 samples will be selected and ows: one sample from the 0 to 2 ft below ground surface (bgs); one sample at the top of the water table; and one sample from each boring will be selected ng or elevated PID reading.
EE 6A
from the 0 to 6-inch depth interval for site characterization. In addition, 3 test pits will be excavated to characterize the old landfill. One soil 65) will be installed downgradient of AREE 6A to evaluate downgradient groundwater quality and the extent of subsurface soil and groundwater ent areas associated with this AREE. Split-spoon samples will be collected from 0-2 ft bgs, 5-7 ft bgs and every 5 ft thereafter until total depth is reached. table for soil borings and 7 feet below the water table for well borings. 3 samples will be selected and sent to the laboratory as follows: one sample from urface (bgs); one sample at the top of the water table; and one sample from each boring will be selected based on obvious soil staining or elevated PID

metals, PCTs, PAHs and TPH. Sediment samples will also be tested for TOC and Grain size distribution.

Table 3-1 (Continued)

WRF RI/FS Groundwater, Surface And Subsurface Samplin

Medium Sampled[1]	Number of Samples	Sample IDs	Chemical Analyses[2]	Physical Testing	
AREE 6B					
Surface Soil	2	RISS24, RISS25	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, PAHs, (surface soil and groundwater only) and TPH.	NA	2 soil samples will collected from the 0 to 6-inch depth i Two test pits (TP18 and TP19) will be excavated to inve will be excavated east of Deephole Point Road to inves pit. A soil boring/monitoring well (MW-60) will be instal boring/monitoring well, MW-75, (also discussed below i this area. Split-spoon samples will be collected from 0- feet below the water table for well borings. 3 samples v top of the water table; and one sample from each borin
Test Pits	3	TP18, 19, 20.		NA	
Subsurface Soil	3	MW-60		1 sample/boring will be analyzed for TOC, Atterberg limits, USCS, Grain size distribution,and percent moisture.	
Groundwater	2[3]	MW-60		Temp, pH, redox, D.O., cond. salinity	
AREE 7					
Subsurface Soil	3	MW-59 (3 samples/boring)	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, TPH, PAHs (GW only).	1 sample/boring will be analyzed for TOC, Atterberg limits, USCS, Grain size distribution,and percent moisture.	Soil boring/monitoring well (MW-59) will be installed in monitoring well MW-59, monitoring well MW-75 (to be in contamination downgradient of this AREE (MW-75 will a collected from 0-2 ft bgs, 5-7 ft bgs and every 5 ft there borings. 3 samples will be selected and sent to the lab sample from each boring will be selected based on obv
Groundwater	2[3]	MW-59		Temp, pH, redox, D.O., cond. salinity	
Downgradient Location From Facility Compound					
Subsurface Soil	3	MW-61 (3 samples/boring)	TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, TPH.	1 sample/boring will be analyzed for TOC, Atterberg limits, USCS, Grain size distribution,and percent moisture.	One soilboring/monitoring well (MW-61) will be installed the northeast portion of the compound. This monitoring upgradient sources.

[1]Forty-five surface water and sediment samples will be collected site wide. These samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, PAHs and TP pH, redox, dissolved oxygen, conductivity, and salinity.

[2]Upon collection, groundwater samples shall be preserved as follows: VOCs pH < 2 with HCl; TAL metals pH < 2 with NHO_3; CN^- pH> 12 with NaOH.

[3]Total number of samples includes two rounds of groundwater samples collected a minimum of 2 months apart.

I (Continued)
e And Subsurface Sampling Program

Rationale
ᴙEE 6B
from the 0 to 6-inch depth interval for site characterization. 19) will be excavated to investigate and characterize metal debris found in an area west of Deephole Point Road in this AREE. An additional test pit (TP20) eephole Point Road to investigate a suspected disposal area where TPH was detected during the 1993 SI. Two soil samples will be collected from each test well (MW-60) will be installed upgradient of this AREE (which is also upgradient of AREE 7) to evaluate groundwater quality. Downgradient soil 75, (also discussed below in AREE 7) will be installed downgradient from AREEs 6B, and 7 to evaluate groundwater quality and subsurface soil conditions in les will be collected from 0-2 ft bgs, 5-7 ft bgs and every 5 ft thereafter until total depth is reached. Total depth will be the water table for soil borings and 7 or well borings. 3 samples will be selected and sent to the laboratory as follows: one sample from the 0 to 2 ft below ground surface (bgs); one sample at the one sample from each boring will be selected based on obvious soil staining or elevated PID reading.
REE 7
MW-59) will be installed in AREE 7. Subsurface soil and groundwater data collected from MW-59 will be evaluated to characterize the site. In addition to itoring well MW-75 (to be installed downgradient of AREEs 6B and 7) will be used to evaluate groundwater quality and the extent of groundwater of this AREE (MW-75 will also be used to evaluate groundwater quality downgradient of AREE 6B, as previously discussed). Split-spoon samples will be 7 ft bgs and every 5 ft thereafter until total depth is reached. Total depth will be the water table for soil borings and 7 feet below the water table for well selected and sent to the laboratory as follows: one sample from the 0 to 2 ft below ground surface (bgs); one sample at the top of the water table; and one ll be selected based on obvious soil staining or elevated PID reading.
h From Facility Compound
ell (MW-61) will be installed in a downgradient location at the corner of the Bayview Road and Charlie Road. This area receives surface water runoff from compound. This monitoring well will be installed to determine whether groundwater or subsurface soils have been impacted by run off or other potential

metals, PCTs, PAHs and TPH. Sediment samples will also be tested for TOC and Grain size distribution and surface water samples will measured for temperature,

Medium Sampled[1]	Number of Samples	Sample IDs	Chemical Analyses[2]	Physical Testing	
					Downgradient Location From Facility Compound (C
Groundwater	2[3]	MW-61	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, TPH, PAHs	Temp, pH, redox, D.O., cond. salinity	(See Above)
					AREEs In The Vicinity of Building 202 (AREEs 11, 17, 22, 23(b), 2
Surface Soil	3	RISS51 - 53	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, PCTs	NA	3 soil samples will collected from the 0 to 6-inch dep
Test Pits	NA	TP21 and TP22	NA	NA	Five shallow soil boring/monitoring wells (MW-55 - M suspected source areas to evaluate the extent of sub which receives surface water runoff and is also down Oil/Water Separator was encountered during the rem source area. Groundwater samples collected from w migration of PCBs and TPH detected in this area. M discharge to Ditch 22. Deep monitoring well MW-84 and lower groundwater zones are contaminated from Phase II Site Characterization, will be sampled for thi measurements will be collected from all existing wells paved area west of the oil/water separator to evaluat AREE 17 is also being sampled in the Phase II SSI. action as follows: One soil boring (RISB3) will be dri adjacent to the sidewall of the PCB excavation ditch and monitoring wells MW-56 and MW-62 to evaluate
Subsurface Soil	27	MW-55, 56, 57, 58, and RISB1-RISB5 (3 samples/boring)	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, PCTs, PAHs (groundwater only), TPH.	1 sample/boring will be analyzed for TOC, Atterberg limits, USCS, Grain size distribution,and percent moisture.	
Groundwater	12[3]	New shallow wells: MW-55, 56, 57, 58 and 85. Deep wells: MW-62 and 84. Existing well: MW-39		Temp, pH, redox, D.O., cond. salinity	

[1]Forty-five surface water and sediment samples will be collected site wide. These samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, PAHs and temperature, pH, redox, dissolved oxygen, conductivity, and salinity.

[2]Upon collection, groundwater samples shall be preserved as follows: VOCs pH < 2 with HCl; TAL metals pH < 2 with NHO_3; CN^- pH> 12 with NaOH.

[3]Total number of samples includes two rounds of groundwater samples collected a minimum of 2 months apart.

Rationale
ı Facility Compound (Continued)
҆EEs 11, 17, 22, 23(b), 24(a), 24(c), And 24(d))
from the 0 to 6-inch depth interval for site characterization.
ıitoring wells (MW-55 - MW-58 and MW-85) and two deep monitoring wells (MW-62 and MW-84) will be installed in downgradient locations from the ɛvaluate the extent of subsurface soil and groundwater contamination. MW-55 is located in an area where stressed vegetation has been observed in an area ɪr runoff and is also downgradient from the former Oil/Water Separator. As previously discussed, a sand lens, which is believed to trend northwest from the countered during the removal action. Shallow monitoring well MW-56 and deep monitoring well MW-62 will be installed in a downgradient location from the samples collected from wells MW-56 and MW-62 will be analyzed to evaluate whether upper and lower groundwater zones are contaminated from the detected in this area. Monitoring wells MW-57, MW-58, and MW-85 are located adjacent to Ditch 22 to evaluate groundwater quality prior to potential p monitoring well MW-84 will be clustered with existing well MW-39, and groundwater samples from these wells will be analyzed to evaluate whether upper ɜs are contaminated from the migration of PCBs and TPH detected in this area. Existing monitoring wells MW-37, and MW-38 which were installed as part of a ɪn, will be sampled for this RI to investigate groundwater quality downgradient of the Drum Storage Area (AREE 12) and AREEs 11 and 23. Water level :ted from all existing wells in this area to extend the data base for the hydrogeologic model. In addition, 2 soil borings (RISB1 and RISB2) will be drilled in the ɾater separator to evaluate the extent of subsurface soil contamination in this area and to characterize and delineate the extent of contamination in AREE 17. ɔled in the Phase II SSI. Soil borings will be drilled to evaluate the extent of contamination in the sand lens which was encountered during the PCB removal boring (RISB3) will be drilled adjacent to the headwall along Locust Road where the culvert crosses under the road. Soil boring RISB4 will be drilled he PCB excavation ditch where the 210 ppm residual PCBs were detected. Soil boring RISB5 will be drilled in the area between the PCB excavation ditch ̧ and MW-62 to evaluate potential subsurface soil contamination in that area.

metals, PCTs, PAHs and TPH. Sediment samples will also be tested for TOC and Grain size distribution and surface water samples will measured for

Table 3-1 (Continued)
WRF RI/FS Groundwater, Surface And Subsurface Samp

Medium Sampled[1]	Number of Samples	Sample IDs	Chemical Analyses[2]	Physical Testing	
					AREE 8
Groundwater	4[3]	Existing wells: MW-33 and MW-34	TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH.	Temp, pH, redox, D.O., cond. salinity	Existing monitoring wells MW-33 and MW-34 will be s
					AREE 12
Groundwater	4[3]	Existing wells: MW-37 and MW-38	TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH.	Temp, pH, redox, D.O., cond. salinity	Existing monitoring wells MW-37 and MW-38 will be s
					AREE 14
Groundwater	2[3]	Existing well; MW-35	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, TPH, PAHs	NA	Existing monitoring well MW-35 will be sampled to inv
					AREE 23A
Subsurface Soil	3	RISB13 (3 samples/boring)	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, TPH.	1 sample/boring will be analyzed TOC, Atterberg limits, USCS, Grain size distribution,and percent moisture.	One soil boring will be installed at the prior location o of the prior excavation is reached. A split-spoon samp

[1]Forty-five surface water and sediment samples will be collected site wide. These samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, PAHs and pH, redox, dissolved oxygen, conductivity, and salinity.

[2]Upon collection, groundwater samples shall be preserved as follows: VOCs pH < 2 with HCl; TAL metals pH < 2 with NHO_3; CN^- pH> 12 with NaOH.

[3]Total number of samples includes two rounds of groundwater samples collected a minimum of 2 months apart.

(Continued)
And Subsurface Sampling Program

Rationale
IEE 8
'-33 and MW-34 will be sampled during the RI to evaluate groundwater quality downgradient of AREE 8.
EE 12
'-37 and MW-38 will be sampled during the RI to evaluate groundwater quality downgradient of AREE 12.
EE 14
35 will be sampled to investigate groundwater quality downgradient of AREE 14.
E 23A
ed at the prior location of an UST adjacent to Building 101. Drilling will proceed through the soil fill and the soil cuttings will be monitored until the bottom hed. A split-spoon sample will be collected from the bottom of the boring.

ıetals, PCTs, PAHs and TPH. Sediment samples will also be tested for TOC and Grain size distribution and surface water samples will measured for temperature,

Table 3-1 (Continued)
WRF RI/FS Groundwater, Surface And Subsurface Sam

Medium Sampled[1]	Number of Samples	Sample ID	Chemical Analyses[2]	Physical Testing	
Facility- Wide Characterization Which Includes AREEs 2					
Surface Soil	25	RISS26-RISS50	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, TPH, PCTs (optional), PAHs.	NA	Twenty-five surface soil samples will be collected from 0 t laboratory will be instructed to analyze for PCTS.
Site Hydrogeologic Evaluation					
Subsurface Soil	27	PZ-3, 4, 5, 6, 7, 8, 9, 10, 11. 3 (samples/boring)	TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics Samples collected from PZ-3 will also be analyzed for TPH.	1 sample/boring will be analyzed TOC, Atterberg limits, USCS, Grain size distribution,and percent moisture.	8 soil borings will be installed to further characterize the s samples will be collected from 0-2 ft bgs, 5-7 ft bgs and e will be selected and sent to the laboratory as follows: one be selected based on obvious soil staining or elevated PI piezometers to use for the facility hydrogeologic model.
Piezometers	8	PZ-3, 4, 5, 6, 7, 8, 9, 10, 11		NA	

[1] Forty-five surface water and sediment samples will be collected site wide. These samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, PAHs a

[2] Upon collection, groundwater samples shall be preserved as follows: VOCs pH < 2 with HCl; TAL metals pH < 2 with NHO_3; CN^- pH> 12 with NaOH.

'able 3-1 (Continued)
, Surface And Subsurface Sampling Program

Rationale
ation Which Includes AREEs 25, 26, 27, and 35
amples will be collected from 0 to 6-inches bgs throughout these areas to identify potential sources of contamination. If PCBs are detected in a soil sample then the ed to analyze for PCTS.
Hydrogeologic Evaluation
illed to further characterize the soil at WRF. These borings will be converted to piezometers to develop the hydrogeologic characteristics of the site. Split-spoon from 0-2 ft bgs, 5-7 ft bgs and every 5 ft thereafter until total depth is reached. Total depth will be 7 feet below the water table for piezometer borings. 3 samples to the laboratory as follows: one sample from the 0 to 2 ft below ground surface (bgs); one sample at the top of the water table; and one sample from each boring will vious soil staining or elevated PID reading. In addition, water level measurements will be collected from newly-installed and existing monitoring wells, and facility hydrogeologic model.

CBs, TAL metals, PCTs, PAHs and TPH. Sediment samples will also be tested for TOC and Grain size distribution.

NaOH.

4.0 TECHNICAL APPROACH TO FIELD OPERATIONS

This section describes the procedures that will be followed during the field work to be conducted at WRF. The elements discussed in this section include: site safety procedures and logistics; surveying and establishment of a grid system; drilling and subsurface soil sampling; monitoring well installation; piezometer installation; water-level measurements; groundwater, surface water, surface soil, and sediment sampling; biological/ecological surveys; equipment decontamination procedures; and sample shipment/chain of custody.

4.1 SURVEYING AND ESTABLISHMENT OF GRID SYSTEM

A consistent and accurate mapping system does not exist for WRF and there are no established permanent benchmarks in the area. A site topographic survey and establishment of permanent benchmarks is essential to delineate the locations of AREEs, and locations of monitoring wells, soil borings, piezometers, and staff gauges. Therefore, a State of Virginia licensed surveyor will be retained to perform surveying activities at WRF. Surveying activities, including loop closure, will meet USAEC Geotechnical Requirements.

4.1.1 Establishment of Permanent Markers

Five (5) permanent reference markers will be established at WRF. The markers will be established by surveying a transect from a nearby surveyed point. These reference markers will be surveyed to an accuracy of 1 foot in lateral coordinates (referenced to Virginia State Planar coordinates), and to an accuracy of 0.01 foot in elevation, referenced to the National Vertical Datum of 1929.

4.1.2 Topographic Map

A low-altitude aerial survey using stereographic coverage will be conducted over the entire WRF. A topographic map on a scale of 1 inch equal to 50 feet will be constructed using 2-foot contour intervals. The Virginia State Planar Coordinate system will be used as the reference coordinate system.

4.1.3 Surveying of Monitoring Wells, Soil Borings, Piezometers and Staff Gauge Locations

Following completion of well installation as described in Section 4.2, existing and new monitoring wells (17 existing wells and 34 newly-installed wells), 7 soil borings, 11 piezometers, and 10 staff gauge locations at the WRF area shall be surveyed in elevation and coordinates. Elevations for the natural ground surface (rather than the top of the coarse gravel blanket) and the highest point on the rim of the uncapped well casing (rather than the protective casing) for each well site shall be surveyed to within $\pm$ 0.05 foot ($\pm$1.5 centimeters) using the National Vertical Datum of 1929. Each well, boring, piezometer, and staff gauge installed will be topographically surveyed using the Virginia State Planar Coordinate system to within $\pm$ 3.0 feet. As required by USAEC guidance documents, surveying accuracy will be verified by loop closure. Documentation that loop closure was performed will be provided in the RI report. IRDMIS map files will be created for the new or revised coordinates and wellhead elevations. A surveyor licensed by the Commonwealth of Virginia will be retained to perform surveying activities at the WRF. Surveying activities, including loop closure, will meet USAEC Geotechnical Requirements.

4.2 MONITORING WELL DESIGN AND CONSTRUCTION

Drilling and subsurface soil sampling will be performed to investigate the nature and extent of contamination at WRF, in addition to extending the current database on the lithology and stratigraphy underlying the facility. Monitoring wells will be installed in selected locations to address data gaps based

on previous investigations. Soil borings and piezometers, as well as shallow and deep monitoring wells, will be located in areas where further data concerning groundwater quality, subsurface soil quality, and groundwater elevation control is needed.

Standard operating procedures have been developed for drilling within WRF in accordance with USAEC Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports (March, 1987), and will be strictly followed to ensure the safety of drilling personnel. Drilling activities in support of this investigation will be performed by a drilling contractor under a subcontract agreement with ICF KE. Clearance of underground utilities will be arranged through the U.S. Government-appointed WRF Site Manager. Drilling will be performed under the direct supervision of the ICF KE Site Geologist.

Monitoring wells will be installed in accordance with USAEC Geotechnical specifications, using flush-threaded Schedule 40, 4-inch diameter PVC casing and screen for shallow monitoring wells and flush-threaded Schedule 80, 4-inch diameter PVC casing and screen for deep wells. Each screen shall be 10 feet in length, have factory 0.01-inch slot size, and a 6-inch solid bottom cap. The PVC materials used for well construction at WRF will conform to National Sanitation Foundation Standard 14 for potable water usage or American Society for Testing and Materials (ASTM) equivalent. Screens and casing will be decontaminated following procedures outlined in Section 4.8.2 prior to transportation to the drill site. No plastic solvents or glues will be used on any of the well materials.

Table 4-1 (all tables are located at the end of this section) summarizes the locations, depths, and construction materials for existing groundwater monitoring wells to be sampled during the RI/FS.

4.2.1 Boring and Shallow Monitoring Well Procedures

4.2.1.1 Shallow Drilling. A total of forty-seven shallow soil borings will be drilled and sampled throughout the site in order to further assess possible subsurface soil contamination within these areas. Both a truck-mounted rig and an all-purpose terrain vehicle (A.T.V.) rig will be used during field activities. Much of the topography throughout WRF is characterized as steeply-sloped and heavily-wooded, with marshy areas adjacent to creeks. Many areas requiring subsurface investigation are within very rugged terrain; therefore, the A.T.V. rig will be used to access these drilling locations.

All shallow soil borings will be drilled initially with 6 1/4-inch I.D. hollow stem augers for the purpose of split-spoon collection. For each boring that will be used for the installation of monitoring wells, the borehole will be over-reamed using 8 1/4-inch I.D. (12 1/2-inch O.D.) hollow-stem augers, prior to initiating well installation procedures. All well installations will proceed within the auger column due to the lithologic characteristics (running sands) associated with the water- table aquifer. The increased diameter of the larger augers is necessary to prevent bridging of the filter pack during installation.

Split-spoon samples will be collected at five-foot intervals from each boring using a 2-inch O.D. 2.0-foot split-barrel sampler (ASTM Method 1586) until reaching total depth. A total of three samples per boring will be submitted for chemical analyses. One soil sample will be collected from the 0- to 2-ft depth interval, and one soil sample will be collected from the water table and submitted for chemical analysis from each boring. In addition, one sample per boring will be collected from field-determined depths exhibiting contamination based on PID field screening, obvious staining, soil discoloration, and odor. If no indications of contamination are present, the remaining sample will be selected from zones of lithologic change within the boring. One physical sample per boring will be submitted from the water table for geotechnical analyses.

Twenty-nine shallow borings will be used for the installation of monitoring wells (MW-52 - 61, 64 - 81, and MW-85) and will be advanced 7 feet into the first encountered water-bearing zone. Each monitoring well will be designed with 3 feet of screen above the water table and 7 feet of screen extending into the water table. This will allow sufficient screen coverage above the water table to accommodate seasonal water level fluctuations, thus permitting the detection of free-phase hydrocarbons during periods of increased precipitation. Anticipated total well depths are approximately 35 feet (±10 feet), based on boring logs

from wells previously installed at WRF.

Eighteen soil borings, within which 11 piezometers (PZ-3 through 13) are to be installed, will be drilled approximately 7 feet into the first-encountered water-bearing zone. Each piezometer will be constructed using 10 feet of screen placed at the bottom of the well, thus positioning approximately 7 feet of screen within the water table and 3 feet of screen directly above the water-table to accommodate future water table fluctuations. Projected total depths for piezometers are 25 feet.

The remaining seven borings (RISB1 through RISB7) not converted to piezometers will be grouted to the surface by pumping a 20:1 mix of cement and bentonite through a tremie pipe from the bottom of the borehole to ground surface. If the total depth of the soil borings are less than 10 feet, the augers will be removed and grout will be mixed and poured into the boring from the ground surface. The grouting will continue until the grout flows from the borehole at ground surface. The augers will be removed in a phased approach to ensure that at least 10 feet of grout remain inside the augers at all times.

Soil cuttings generated during drilling will be collected in drums and labeled with weatherproof marking showing the date, boring number, location, depth range, and contents of each drum. The drums will be sealed and staged in a secure area until analytical results are available, at which point disposal options will be reviewed as described in Section 9.0

4.2.1.2 Shallow Monitoring Well Installation. Each well installation will begin within 12 hours of boring completion, and once begun, will continue uninterrupted until well installation is complete or until the bentonite seal is in place. The borehole will be maintained in a plumb and true condition during drilling through leveling of the drill rig prior to drilling and maintaining a drilling speed that is sufficiently low to prevent deviation of the borehole. Borings to be completed as four-inch monitoring wells will be over-reamed using 8 1/4-inch I.D. hollow stem augers. Upon reaching total depth, the augers will be rotated until no additional cuttings are returned to the surface.

After attaching the bottom cap to the screen end, each casing section will be threaded to the section immediately below it and lowered into the boring. Clean latex gloves will be worn at all times during the handling of well screens and casing. The sand pack filter material will consist of sieve size 20/40 silica sand. Filter pack installation is accomplished by the washing of sand through a tremie pipe placed two feet from the bottom of the boring. The tremie pipe will be raised to remain one to two feet above the top of the sand, as the level of sand in the annular space increases. The auger column will be raised during filter pack installation; however one to two feet of sand will remain within the augers to prevent possible bridging of the sand. The filter pack will be installed to a minimum height of five feet above the top of the well screen. The height of the sand pack will be verified during installation to ensure proper sand placement.

The bentonite seal consists of bentonite pellets which will be installed directly over the top of the filter pack. The bentonite pellets will be poured down the tremie pipe (to be placed approximately 6 feet above the anticipated top of the bentonite) as the auger column is raised to a height directly above the top of the bentonite and will remain in place during installation. The bentonite seal will have a minimum thickness of five feet. Once placed at the proper depth, it will be allowed to hydrate for a minimum of 2 hours before the remaining annular space is grouted.

A gel-cement grout seal composed by weight of 20 parts Type II Portland cement to one part bentonite combined with a maximum of 8 gallons of approved water per 94-pound bag of cement will be installed from the top of the bentonite seal to 2.5 feet below ground surface. Grouting will be performed in a

continuous operation in the presence of the Site Geologist. The grout will be pumped into the annular space under pressure using a tremie pipe (always located no greater than 5 feet from the top of the grout) as the augers are gradually withdrawn. If the annular space to be grouted is ten feet or less from ground surface, the grout will be mixed and poured into the annular space from ground surface after removing the auger. After the grout seal has set (approximately 24 hours), it will be checked for settlement and additional grout will be added when necessary to fill any depressions (up to 2.5 feet below ground surface). Once the grout seal is complete and has set, the protective steel casing will be cemented into the borehole.

An 8-inch protective steel casing will be installed over the top of the riser, which will extend approximately 2.5 feet above ground surface, and will be sealed 2.5 feet into the grout. The casing will include a padlocked, hinged cap. The same key will be used for every padlock on the newly-installed wells. The well will be vented to the atmosphere via a loose-fitting PVC cap, which will prevent entry of water but is not airtight. This design allows the well to be open to the atmosphere for groundwater level stabilization. An internal mortar collar will be placed within the well/protective casing annulus from ground surface to 0.5 foot above ground surface. In accordance with the USAEC Geotechnical Requirements (USAEC, 1987), a 0.25-inch diameter drainage port will be installed, centered 1/8-inch above the level of the internal mortar collar.

A concrete protective pad will also be installed around each well. The exterior of the protective casing will be painted safety orange and the well designation will be permanently marked on the top and side of the protective casing. Four steel posts, each radially located within 3 feet of the well, and placed two to three feet below ground and extending three feet above ground surface will be cemented into the protective concrete pad. These posts will also be painted safety orange in order to facilitate observation from a distance. Posts will be flagged in areas that are prone to overgrowth by vegetation.

Figure 4-1 presents the shallow monitoring well construction diagram.

4.2.2 Deep Monitoring Well Procedures

4.2.2.1 Deep Monitoring Wells. The subsurface stratigraphy at WRF is not well understood at this time. Two water wells have been drilled on the site and the subsurface description for Well No. 1 has been used as a guide to determine which water-bearing zone may be monitored at the site. The drilling log from water Well No. 1 (USGS, 1981) indicates that the subsurface stratigraphy consists of interbedded sands, clays, and sand and gravel zones.

It is proposed that the first water-bearing unit below a confining or semi-confining clay be screened to monitor groundwater quality. It is anticipated that a deeper water-bearing unit will be encountered within 75 feet (± 10 feet) bgs based on the subsurface lithologic descriptions from Water Well No. 1. The clay unit in Well No. 1 was encountered at 49 feet below ground and was 11 feet thick.

Four deep borings will be drilled at WRF using mud rotary techniques for the purpose of four-inch monitoring well installation. The deep background well will be drilled first to be used as a guide to complete the deep well installed where PCB contamination has been detected at Building 202 - Drainage Devices.

The mud rotary drilling method will be used to drill soil borings for the installation of deep monitoring wells at WRF. Mud rotary drilling employs the use of a drilling fluid, composed of bentonite and approved water, which is circulated through the drilling tools and down the hole. The mud rises to the surface carrying soil cuttings which settle out before the mud is recirculated down the hole. The bentonite/water drilling fluid promotes hole stability in poorly-consolidated formations. Soil samples for chemical analysis will not be collected from the borings. A boring log will be developed for each borehole drilled, in

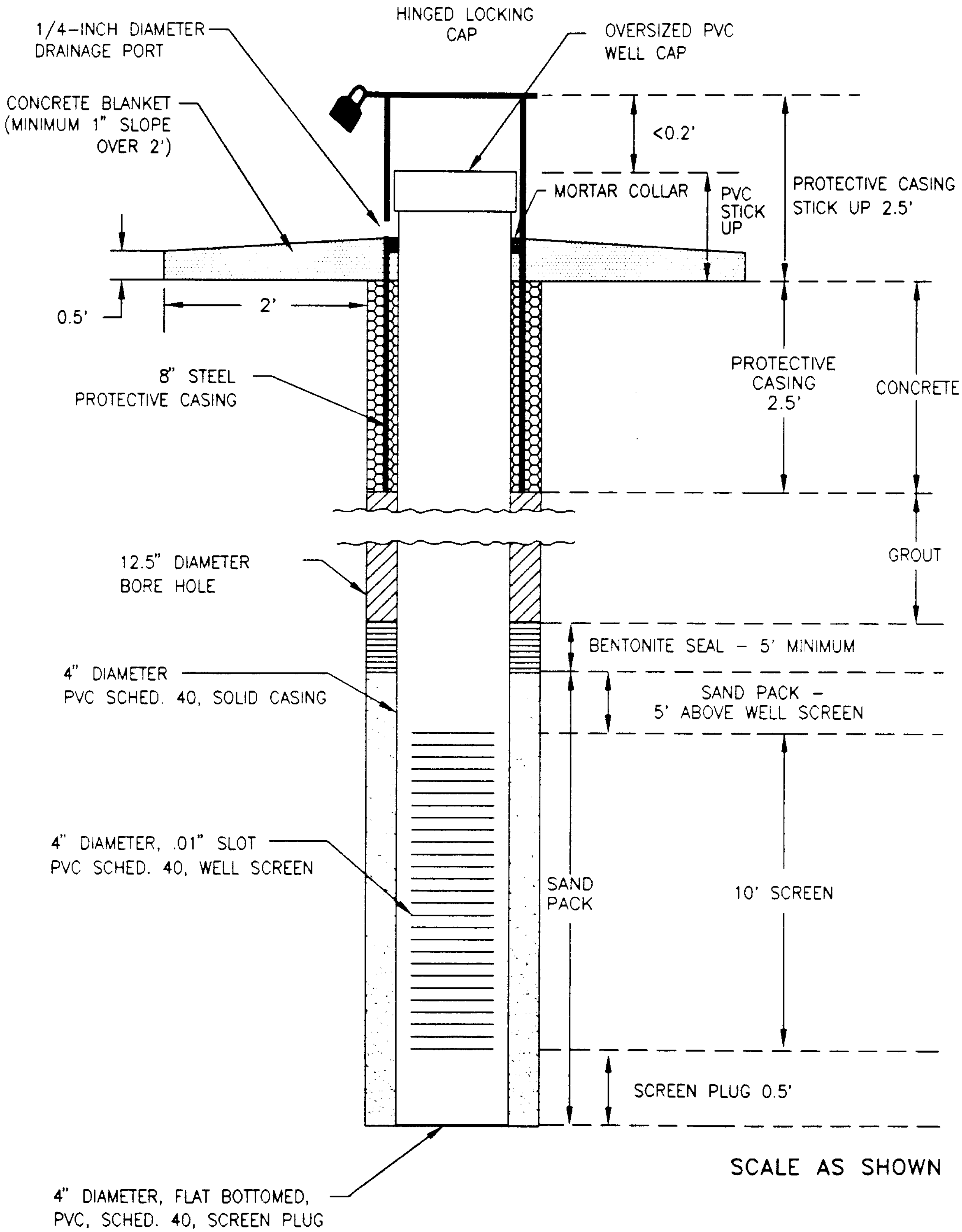


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FIGURE 4-1
SHALLOW MONITORING WELL CONSTRUCTION DIAGRAM

accordance with Section 4.2.3. The following procedures will be followed in preparation for the drilling of each deep monitoring well borehole:

a. Prior to arriving at the monitoring well site, all drill pipes, sampling rods, and other downhole equipment will be decontaminated according to the procedures outlined in Section 4.8.1.

b. Plumbness will be obtained in each borehole by careful leveling of the drill rig prior to commencement of drilling.

c. A steel mud pit will be set in place and leveled. The capacity of the mud pit will be calculated by the Site Geologist and any fluid losses/additions will be recorded during drilling operations.

d. The mud pit will be filled with water and powdered bentonite will be added to the water while circulating the mixture through the mud pump to ensure thorough mixing.

e. Care will be exercised to ensure that the mud pit does not leak.

Following these initial setup procedures, a 14-inch drag bit will be attached to the drill pipe and drilling will proceed through the annulus in the mud pit. All drilling mud which circulates to the surface during drilling operations will be contained in the steel mud pit. The mud pit contains three baffled chambers. Two chambers allow settling of the sediments from the mud while the third chamber acts as a suction pit where the pump recirculates the fluid through the drill pipe. Cuttings which settle out during drilling will be removed from the mud pit with a desander and containerized in 55-gallon drums. The drums will be labeled with the monitoring well site designation, date, identification of contents, and depth interval of the cuttings.

Drilling will continue until the first confining clay unit is reached. A split-spoon sample will be collected to confirm the presence of the clay layer. Upon confirmation of the presence of the clay unit, twelve inch, schedule 20, carbon steel casing will be lowered into the borehole, with the bottom of the casing resting upon the confining unit at the bottom of the boring. The boring will then be grouted using a 20:1 Type II Portland cement/bentonite mixture as described in Section 4.2.2.2. The grout will be allowed to set for a minimum of 24 hours before drilling proceeds. After the grout has set, the boring will be redrilled through the surface casing with a 9 7/8-inch drag bit, thus creating sufficient annular space to install a 4-inch PVC screen and casing and providing enough space for annular completion via tremie pipe. Drilling will continue below the confining unit until the total depth of the boring extends 10 feet into the first groundwater encountered below the confining unit. A split-spoon sample will be collected at the depth which corresponds to the screened interval of the well to verify that the well has been set in sand.

4.2.2.2 <u>Deep Monitoring Well Installation</u>. A deep monitoring well construction diagram is shown in Figure 4-2. The monitoring wells will be constructed of flush-threaded Schedule 80 (to prevent warping), 4.0-inch outside diameter PVC casing and screen. The monitoring well screens will be 10 feet in length with factory 0.01-inch slot size and a 6-inch solid bottom cap.

The PVC materials used for well construction at WRF conform to National Sanitation Foundation Standard 14 for potable water usage or ASTM equivalent. All screens and casing will be decontaminated following procedures outlined in Section 4.8.2 prior to transportation to the drill site. No plastic solvents or glues will be used on any of the well materials.

The grout used in well construction will be composed by weight of 20 parts Type II Portland cement to one part bentonite, with a maximum of 8 gallons of approved water per 94-pound bag of cement. Specifications and a sample of bentonite will be submitted to USAEC for approval prior to use. The sand

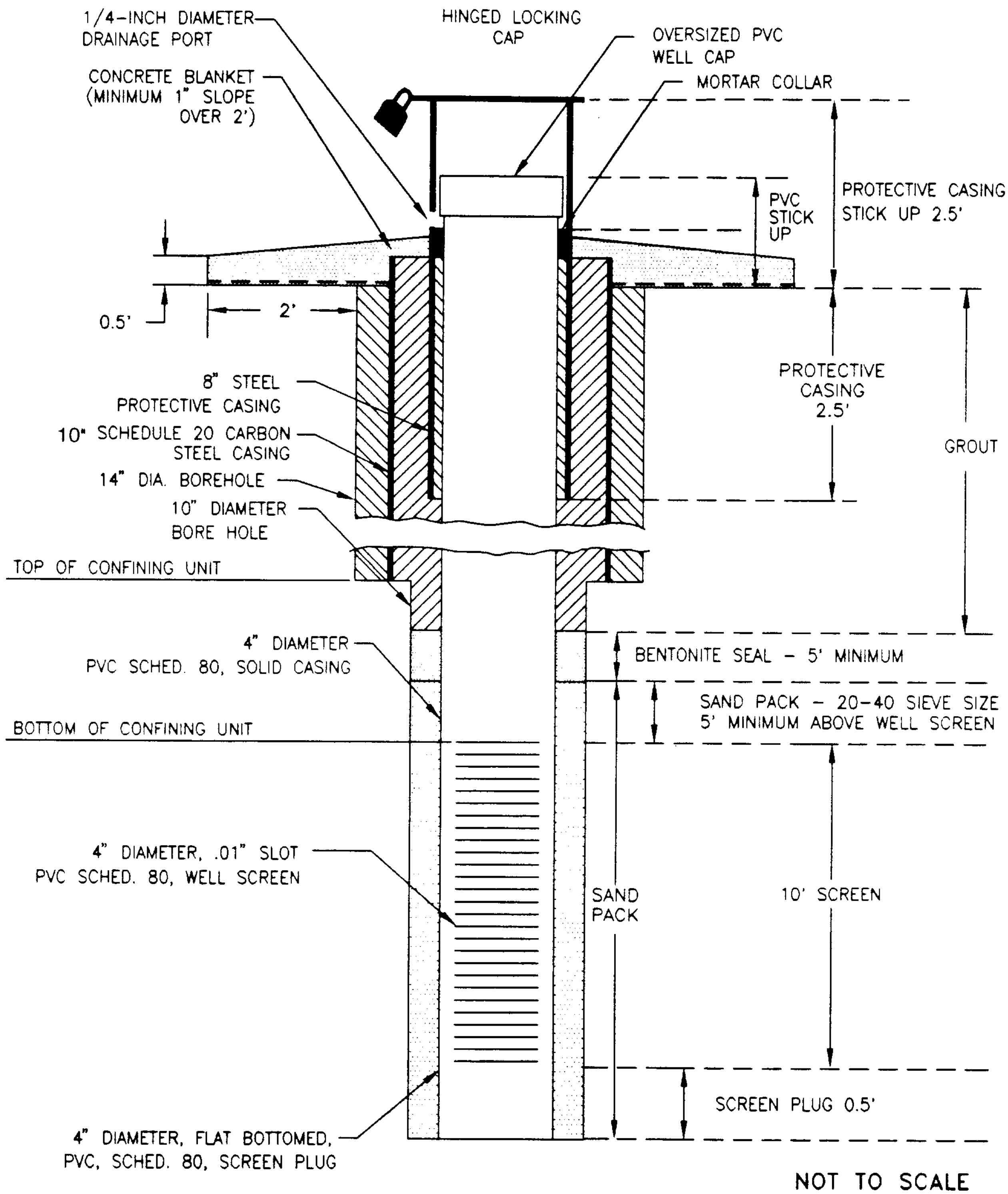

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FIGURE 4-2
DEEP MONITORING WELL CONSTRUCTION DIAGRAM

pack filter material will consist of 20/40 sieve size silica sand. A jar of the filter material will be submitted to USAEC for approval, along with information on the lithology, grain-size distribution, and source of the material prior to use.

The Site Geologist will confirm the depth of the borehole before the well screen and casing are installed. All well installations will commence within 12 hours following boring completion and will continue uninterrupted until the bentonite seal is in place. The screen and casing sections will be screwed together and lowered into the borehole. Clean gloves will be worn at all times during the handling of well screens and casing.

The filter pack will be installed through a tremie pipe around the well screen to a height of approximately 5 feet above the well screen. The thickness of the sand pack will be verified by tagging the top of the sand pack with a weighted tape during installation to ensure proper sand placement. The filter pack and bentonite seal thickness may need to be adjusted based on the thickness of the clay unit to insure that the bentonite seal is placed in the clay unit.

The bentonite seal will consist of bentonite pellets which will be installed above the filter pack using a tremie pipe. The bentonite seal will have a minimum thickness of 5 feet. Once installed at the proper depth, the seal will be allowed to hydrate for a minimum of 2 hours before initiating grouting. The thickness of the bentonite seal will be verified during installation to ensure proper seal placement.

A gel-cement grout seal consisting of Type II Portland cement and bentonite will be installed from the top of the bentonite seal to 2.5 feet below ground surface. Grouting will be performed in a continuous operation in the presence of the Site Geologist. The grout will be pumped into the annular space under pressure using a tremie pipe. After the grout seal has set (approximately 24 hours), it will be checked for settlement and additional grout will be added to fill any depressions (up to 2.5 feet below ground surface). Once the grout seal is complete and has hardened, the protective steel casing will be cemented into the borehole.

A protective steel casing, placed between the outer steel casing and the PVC riser, (8 inch diameter) will be installed over the top of the riser. The protective casing will extend approximately 2.5 feet above ground surface and will be sealed 2.5 feet into the grout. The steel casing will include a padlocked and hinged cap. The same key will be used for all padlocks on the newly-installed wells. The well will be vented to the atmosphere via a loose-fitting PVC cap, which prevents entry of water but is not airtight. This design decreases pressure build-up within the well and allows water level stabilization. An internal mortar collar will be placed within the well/protective casing annulus from ground surface to 0.5 foot above ground surface. In accordance with the geotechnical requirements (USAEC, 1987a), a 0.25-inch diameter drainage port will be installed, centered 1/8-inch above the level of the internal mortar collar.

A concrete protective pad will be installed around each well. The exterior of the protective casing will be painted orange and the well designation will be permanently marked on the top and side of the protective casing. Four 3-inch diameter steel posts, each radially located within 3 feet of the well and placed 2 to 3 feet below ground and extending 3 feet above ground surface will be cemented into the protective concrete pad. These posts will also be painted in order to facilitate observation from a distance. Posts will be flagged in areas that were prone to overgrowth by vegetation.

4.2.3 Stratigraphic Characterization

The on-site geologist will enter a full description of the drilling and sampling activities associated with each boring into a borelog. An original log will be produced; transcribing a log from a field notebook to log form will not be permitted. Original boring logs will be submitted to USAEC within three days following completion of the boring. The following information will be recorded in the field log by an ICF KE

geologist during the course of drilling and sampling activity:

a. Depths of the boring in feet and fractions thereof (tenths of feet);

b. Soil descriptions, in accordance with the Unified Soil Classification System (USCS), including;

   1. Classification,
   2. USCS symbol,
   3. Secondary components and estimated percentage,
   4. Color (using Munsell Soil Color Chart),
   5. Plasticity,
   6. Consistency (cohesive soil) or density (noncohesive soil),
   7. Moisture content,
   8. Texture/fabric/bedding,
   9. Grain angularity; and
   10. Depositional Environment

c. Cutting descriptions, including basic classification, secondary components, and other apparent parameters;

d. Numerical, visual estimates of secondary soil constituents (if terms such as "trace", "some", or "several" are used, their quantitative meanings will be defined in a general legend);

e. Length of sample recovered in the split spoon (% recovery);

f. Blow counts, hammer weight, and length of fall for split-spoon samples;

g. Estimated depth interval for each sample;

h. Depth to water first encountered during drilling and the method of determination (Any distinct water-bearing zones below the first zone will also be noted);

i. General description of the drilling equipment used, including the rod size, bit type, pump type, rig manufacturer, model, and names of drilling personnel;

j. Drilling sequence;

k. Any unusual problems;

l. Start and completion dates of borings, and a chronological time-sequence of events;

m. Lithologic boundaries;

n. Fluid losses where applicable;

4.2.4 Well Development

Newly-installed wells will be developed according to USAEC Geotechnical Requirements (March, 1987). Development will be performed no less than two days and no longer than seven days after well installation is complete.

Monitoring wells will be developed by an electric-powered submersible pump and will proceed until the development water achieves visual clarity or until field parameters have stabilized. At least five well volumes (including the saturated filter material in the annulus) will be removed from shallow monitoring well. For deep monitoring wells, a minimum of 5 well volumes (including the filter pack material in the annulus) plus 5 times the total fluid loss from drilling will be removed. Field parameters including pH, conductivity, temperature, redox potential, and dissolved oxygen will be monitored periodically during development and recorded until stabilization is achieved. Stabilization is defined as successive readings in which the pH has changed by less than 0.1 pH units, temperature has changed 1 degree F or less, and conductivity has changed by less than 10%. Surging and swabbing (repeatedly raising and lowering the pump within the screen while pumping) will be performed to ensure vigorous, back-and forth flow across the screen. Water will not be added to the wells to aid in development, nor will any type of air-lift techniques be used. The pump will be decontaminated according to the procedures outlined in Section 4.8.3 and allowed to dry before use in each well.

The following data will be recorded during development:

a. Well designation;

b. Date of well installation;

c. Date of development

d. Static water level before and 24 hours after development;

e. Quantity of water lost during drilling (where applicable) and fluid purging;

f. Quantity of standing water in well and annulus (30 percent porosity assumed for calculation) prior to development;

g. Specific conductance, temperature, pH, redox potential, and dissolved oxygen measurements taken and recorded at 15 minute intervals throughout the development process;

h. Depth from top of well casing to bottom of well;

i. Screen length;

j. Depth from top of well casing to top of sediment inside well, before and after development;

k. Physical character of removed water, including changes during development in clarity, color, particulate, and odor;

l. Type and size/capacity of pump and/or bailer used;

m. Description of surge technique, if used;

n. Height of well casing above ground surface; and

o. Quantity of water removed and removal time.

Before well development begins and upon completion, the total depth of the well will be measured using a weighted tape to calculate the thickness of sediment removed from the well during development. The height of sediments after development shall not exceed 1% of the total length of the well screen. The well development water will be containerized and disposed of in accordance with the procedures discussed in Section 9.0. For each well, a 1-pint sample of the final water to be removed during development will be placed in a clear container and labeled with well number and date. Each development sample will be provided to USAEC in a timely manner.

4.3 WATER LEVEL/FREE-PHASE HYDROCARBON MEASUREMENTS

Depth to water measurements and depth to product measurements for wells (34 new monitoring wells, 11 piezometers, and 17 existing wells) included in the water level survey will be collected within a 24-hour period. An electric oil/water interface probe with an accuracy of 0.01 foot will be used to obtain depth to water/depth to product measurements. All measurements will be measured from a permanently marked reference point located on the top of the riser pipe. Measurements will be taken three times to ensure accuracy. The tape and probe will be rinsed with deionized water, cloth-wiped, and allowed to air dry between water level measurements at different wells.

Depth to water measurements will be used to construct a map illustrating potentiometric elevations in the upper portion of the shallow aquifer, i.e. shallow monitoring wells and piezometers. These data will be used in determining groundwater flow direction and the horizontal hydraulic gradient across the facility.

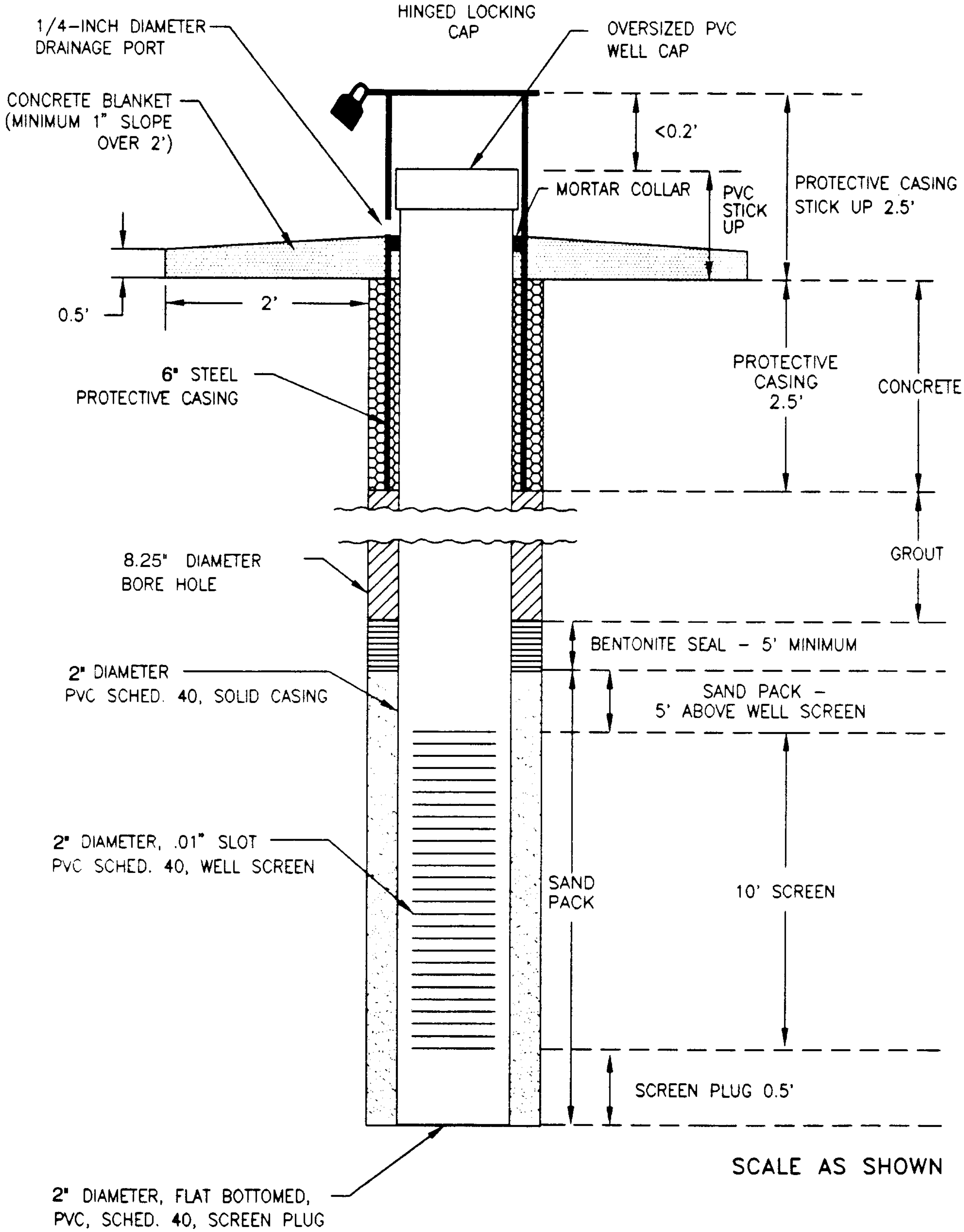
4.4 PIEZOMETERS FOR GROUNDWATER ELEVATION CONTROL

Eleven piezometers (PZ-3 through PZ-13) will be installed for groundwater elevation control to determine site groundwater flow direction. Subsurface soil samples will be collected from the piezometer borings (3 samples/boring) and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, and TAL metals (refer to Table 3-1). Select piezometers will also be analyzed for TPH. Two of the piezometers (PZ-5 and PZ-12) are located in AREEs to investigate subsurface soil contamination as well as establish groundwater elevation control.

4.4.1 Piezometer Installation

Eleven soil borings will be converted to 2-inch piezometers with estimated total depths of 25 feet. Soil borings within which two-inch piezometers will be installed will be drilled using 6 1/4 inch I.D. hollow stem augers. The technical approach with respect to drilling and sampling during advancement of piezometer borings will be identical to procedures described for shallow monitoring well drilling (Section 4.2.1.1). The screened interval for these piezometers will be 10 feet, with 7 feet of screen extending into the water table and 3 feet above. The piezometers will be used as a permanent means of assessing groundwater flow direction and will not be included in groundwater sampling events. Figure 4-3 presents a diagram detailing proposed WRF piezometer construction.

Soil boring construction will proceed in much the same manner as described in the previous section detailing monitoring well installation. Upon reaching the total depth, the augers will be rotated until no additional cuttings are returned to the surface. Piezometers will be constructed using flush-threaded Schedule 40, 2-inch diameter casing and screen. The piezometer screens will be 10 feet in length, have factory 0.01-inch slot size and a 6-inch solid bottom cap. The total depth of each boring will be tagged with a weighted tape before initiating piezometer completion. The screen and each casing section will



SCALE AS SHOWN

ICF KAISER ENGINEERS

FIGURE 4-3
PIEZOMETER CONSTRUCTION DIAGRAM

be threaded together one section at a time as the casing is manually advanced downhole. Upon addition of the final casing length, the bottom of the piezometer will rest on the bottom of the boring during annular completion.

The sand pack filter material will consist of sieve size 20/40 silica sand. Filter pack installation will be accomplished by the washing of sand through a tremie pipe placed 2 feet from the bottom of the boring. The tremie pipe will be raised to remain one to two feet above the top of the sand, as the level of sand in the annular space increases. The filter pack will be installed to a minimum height of 5 feet above the top of the piezometer screen. The height of the sand pack will be verified frequently during installation to insure proper sand placement and to verify that one to 2 feet of filter pack material remains in the augers during installation.

The bentonite seal consists of bentonite pellets which will be installed directly above the top of the filter pack. The bentonite seal will have a minimum thickness of five feet. During this process, the augers will be raised just above the top of the bentonite, as will the tremie pipe, and will not be allowed to touch the top of the bentonite during installation. Once placed at the proper depth, the seal will be allowed to hydrate for a minimum of 2 hours before the remaining annular space is grouted.

A gel-cement grout seal composed by weight of 20 parts Type II Portland cement to one part bentonite, with a maximum of 8 gallons of approved water per 94-pound bag of cement will be installed from the top of the bentonite seal to 2.5 feet below ground surface. Grouting will be performed in a continuous operation in the presence of the Site Geologist. The grout will be pumped into the annular space under pressure using a tremie pipe (always located no greater than 5 feet from the top of the grout) as the augers are gradually withdrawn. After the grout seal has set (approximately 24 hours), it will be checked for settlement and additional grout will be added when necessary to fill any depressions (up to 2.5 feet below ground surface). Once the grout seal is complete and has set, the protective steel casing will be cemented into the borehole.

A 6-inch protective steel casing will be installed over the top of the riser, will extend approximately 2.5 feet above ground surface, and will be sealed 2.5 feet into the grout. The casing will include a padlocked, hinged cap. The same key will be used for all padlocks on the newly-installed piezometers. The piezometer will be vented to the atmosphere via a loose-fitting PVC cap, which will prevent entry of water but is not airtight. This design allows the piezometer to be open to the atmosphere for groundwater level stabilization. An internal mortar collar will be placed within the piezometer/protective casing annulus from ground surface to 0.5 feet above ground surface. In accordance with the USAEC Geotechnical Requirements (USAEC, 1987), a 0.25-inch diameter drainage port will be installed, centered 1/8-inch above the level of the internal mortar collar.

A concrete protective pad will also be installed around each piezometer. The exterior of the protective casing will be painted safety orange and the piezometer designation will be permanently marked on the top and side of the protective casing.

4.5 SAMPLE COLLECTION PROCEDURES

This section briefly outlines sample collection procedures to be used for the WRF RI. Detailed SOPs are provided in the QAPP.

4.5.1 Groundwater Sampling Procedures

The newly-installed monitoring wells will be allowed to stabilize for a minimum of two weeks following well development. After this time has elapsed, groundwater samples will be collected from the thirty-four new wells and seventeen (17) existing wells to determine the nature and extent of contamination in the aquifer system. In addition, a second round of groundwater sampling will be performed at a minimum of 2 months after the initial event is completed. Samples will be collected in a manner which ensures high-quality data and consistency between wells. Work shall be performed in accordance with applicable USAEC, USEPA, and State technical and safety requirements. Table 4-2 summarizes analytical requirements for groundwater samples to be collected.

Pre-sample purging will be accomplished using the USEPA "low flow" sampling technique. Purging will be accomplished using a variable speed submersible pump, provided each well is capable of producing a recharge greater than 0.1 L/min, which is the practical lower limit of pump performance. Wells not capable of this pumping rate will be purged with decontaminated Teflon bailers. Bailers used during purging will be decontaminated in accordance with the procedures outlined in Section 4.8.4.2.

The following sampling procedures will be followed:

1. A clean piece of plastic sheeting will be spread on the ground around the well to protect the sampling equipment.

2. All personnel near the well will wear full-face respirators when the well is being opened. Immediately after opening the well, headspace readings in the well and in the breathing zone immediately above the well will be taken with a photoionization detector (PID).

3. If VOCs are measured in the well, the well will be allowed to ventilate for several minutes. If the readings are continuous, then Level C protection will be worn while purging and sampling the well.

4. The depth to well bottom and depth to free-phase product/groundwater will then be measured with an oil/water interface probe.

5. The well will be purged with a submersible pump. During pumping, the pump will be kept as close to the top of the water column as possible and lowered at the same rate as well drawdown occurs. If a bailer is used, it will be lowered into the well so that splashing does not occur. Purging will begin at the pump's lowest setting, then gradually increase the rate until the pumping rate matches the aquifer recharge rate.

6. Initially, and upon removing three liters of water from the well while pumping, a sample will be collected for pH, temperature, conductivity, redox potential, and dissolved oxygen by triple-rinsing a glass beaker and then filling it with water from the pump or bailer. Temperature, pH, and conductivity measurements will then be collected . These readings will be used to determine if conditions in the well have stabilized. The readings will be recorded on the Well Purge Form along with the time of the reading, the water level reading, description of water, and the cumulative volume extracted. A Hydrolab™ water quality measuring instrument will be used to determine the water quality parameters.

7. A sample will be collected when drawdown has reached an equilibrium level, and the total volume of water purged exceeds the water volume in the screened interval and the surrounding filter pack, and parameters stabilize to within ten percent over three consecutive readings.

8. The sample will be obtained using a Teflon™ double-check valve bailer with a 2-foot Teflon™ coated stainless steel leader and disposable nylon rope.

9. The sample bottles will be triple-rinsed using sample water, except VOC fraction.

10. The sample bottles will be filled in the order of decreasing volatility: TCL VOCs, TCL SVOCs, TPH, TCL pesticides/PCBs, PCTs, and TAL inorganics.

11. The required number of sample bottles, sample container types, and sample preservation methods with respect to specific analytes are defined in the QAPP (USAEC 1995).

12. Sample bottles will be labeled, custody-sealed, enclosed in a plastic bag, and placed in an ice chest maintained at 4±2°C immediately after sample collection and preservation.

13. Obtain a final sample for measurement of pH, temperature, conductivity, redox potential and dissolved oxygen.

14. Stabilization readings, PID readings, purge volume, flow rate, and sample information will be entered into a Field Parameter Form.

15. Disposable sampling equipment will be discarded. The bailer, pump, hose, and beaker will be transported to the decontamination pad and decontaminated according to procedures outlined in Section 4.8.

4.5.2 <u>Subsurface Soil Sampling Procedures</u>

Subsurface soil samples will be collected using a 2-foot, 2-inch diameter, stainless steel split-spoon sampler (ASTM Method 1586). Split-spoon samples will be collected at 5-foot intervals during advancement of each boring until total depth is reached. Boring logs will be developed for each boring as described in Section 4.2.3. Sampling equipment will be decontaminated prior to the collection of each sample following the procedures in Section 4.8.4.2. During drilling, the cuttings from each borehole will be visually inspected and checked with a Photoionization Detector (PID). The drill cuttings will be containerized in drums and labeled with weatherproof markings showing boring number, date, location, and appropriate depth range of contents.

A total of three samples per boring will be submitted for chemical analyses. One soil sample will be collected from the 0 to 2 ft depth interval, and one soil sample will be collected from the water table from each boring and submitted for chemical analysis. In addition, one sample per boring will be collected from field-determined depths exhibiting contamination based on PID field screening, obvious staining, soil discoloration, and odor. If no indications of contamination are present, the remaining sample will be selected from a zone of lithologic change within the boring. One physical sample per boring will be submitted from the water table for geotechnical analyses. Table 4-3 summarizes analytical requirements for subsurface soil samples to be collected.

Once removed from the boring the split-spoon sampler will be opened and the volatile organic aliquot, will be placed directly into the sample container using a clean stainless steel spatula and sealed. The soils will then be described by the field geologist as discussed in Section 4.2.3. Portions of the sample which make contact with the split spoon ends will be discarded from the sample. A stainless steel bowl and trowel will be used to homogenize the remaining soil sample and placed into sample bottles. A label will be affixed to each sample container which includes the project number, sample number, time and date, analysis required and sampler's initials. Samples will be sealed and packed as described in the QAPP. Samples for chemical analyses will always be collected before samples for physical analyses when

collected from the same sampling interval.

Subsequent to these activities, each borehole which is not converted to a monitoring well or piezometer will be abandoned by pumping a 20:1 mix of cement and bentonite through a tremie pipe from the bottom of the borehole to ground surface. The grouting will continue until the grout flows from the borehole at ground surface. The augers will be removed in a phased approach to ensure that at least 10 feet of grout remain inside the augers at all times.

4.5.3 Surface Soil Sampling Procedures

Surficial soil samples will be collected at depths from 0-6 inches using a stainless steel bowl and trowel. The vegetation and root mat will be removed prior to sample collection. Before use, all surface soil sampling equipment will be decontaminated according to the procedures outlined in Section 4.8.4.2.

A description of the soil will be entered into the field logbook and will include primary and secondary constituents, approximate percentages of grain size, and evidence of fauna also will be recorded in the field logbook. The field parameter form will include IRDMIS codes, sample number, date, time, soil description, depth, bottle types, analytical parameters, weather, and sampler's signature. Table 4-4 summarizes analytical requirements for surface soil samples to be collected.

Each bottle containing a sample for chemical analysis will be placed in bubble-wrap then in a water-tight plastic bag. The sample containers will then be packed into plastic ice chests with sufficient ice packs or double-bagged ice to maintain 4±2°C from the time of collection to receipt by the laboratory. If loose ice is used, it will be double-bagged to prevent contact of the meltwater with the samples. The integrity of samples will be insured by checking lid closure prior to shipment. Samples for physical analysis will be shipped to the laboratory without ice.

Detailed SOPs for sample collection, documentation, packaging, and shipment are provided in the QAPP.

4.5.4 Surface Water Sampling Procedures

A Hydrolab™ water quality measuring instrument will be used to measure pH, conductivity, temperature, dissolved oxygen, percent saturation of dissolved oxygen, redox, and salinity at the time of sample collection.

Sample bottles will be triple-rinsed using the sample water prior to collection of the actual sample. Samples for chemical analysis will be collected by turning the bottle upside down and immersing it several inches below the surface of the water. The bottle will be slowly turned upright allowing the air to be released gently and the bottle to fill. When samples are to be collected for VOC analysis, a reverse meniscus will be achieved in order to prevent air from entering the bottle upon capping. If air bubbles are present in the bottle once it is capped, the sample will be recollected. Detailed SOPs for sample collection, documentation, packaging, shipment are provided in the QAPP. Table 4-5 summarizes analytical requirements for surface water samples to be collected.

4.5.5 Storm Event Sampling Procedures

A Hydrolab™ water quality measuring instrument will be used to measure pH, conductivity, temperature, dissolved oxygen, percent saturation of dissolved oxygen, redox, and salinity at the time of sample collection. Sample bottles will be triple-rinsed using the sample water prior to collection of the actual sample. Samples for chemical analysis will be collected by turning the bottle upside down and immersing it several inches below the surface of the water. The bottle will be slowly turned upright allowing the air

to be released gently and the bottle to fill. When samples are to be collected for VOC analysis, a reverse meniscus will be achieved in order to prevent air from entering the bottle upon capping. If air bubbles are present in the bottle once it is capped, the sample will be recollected. Detailed SOPs for sample collection, preservation, documentation, packaging, shipment are provided in the QAPP.

4.5.6 Sediment Sampling Procedures

An Ekman grab or a Wildco Box Core sampler will be used to collect sediments. Sediment samples will be collected from the top 5 cm of sediment at each sample location. Sediment collected for chemical and physical analyses will be placed into a stainless steel bowl. Samples for VOC analysis will be containerized immediately following the sample collection. The VOC sample container will be filled completely to eliminate headspace. The remaining sediment will be homogenized using a stainless steel trowel. Sample containers will be filled in order of decreasing volatility of the chemical to be measured. Sample containers for physical analyses will be filled last. Sediment sample equipment will be decontaminated according to procedures described in the QAPP.

A description of the sediment will be entered into the field logbook and will include primary and secondary constituents, depth of apparent redox potential discontinuity layer (RPD), and approximate percentages of grain size. Other characteristics of the sediment sample such as detritus content, submerged aquatic vegetation (SAV) observed, and evidence of fauna also will be recorded in the field logbook. The field parameter form will include IRDMIS codes, sample number, date, time, soil description, depth, bottle types, analytical parameters, weather, and sampler's signature.

Each sample for chemical analysis will be placed in bubble-wrap then in a water-tight plastic bag. The samples will then be packed into plastic ice chests with sufficient ice packs or double-bagged ice to maintain 4±2°C from the time of collection to receipt by the laboratory. If loose ice is used, it will be double-bagged to prevent contact of the meltwater with the samples. The integrity of samples will be insured by checking lid closure prior to shipment. Samples for physical analysis will be shipped to the laboratory without ice. Detailed SOPs for sample collection, documentation, packaging, and shipment are provided in the QAPP. Table 4-5 summarizes analytical requirements for sediment samples to be collected.

4.6 SURFACE WATER MONITORING

Staff gauges will be installed in drainage ditches at various locations within WRF to aid in the determination of surface water flow and surface water elevation including tidal fluctuations.

4.6.1 Location of Staff Gauge Stations

Staff gauges will be installed at 10 stream locations (SG 1-10) to monitor water level elevations. Staff gauges will be located in all major drainage ways, in Marumsco Creek, and as near as practicable to proposed monitoring well locations. The proposed locations are presented in Figure 3-1. WATER♦MARK™ stream gauges graduated to hundredths of feet with numbered markings in tenths of feet will be installed at bridges crossing the drainages. The installation procedures are as follows:

- The gauge will be set where it can be attached to a wooden brace on the side of the bridge;
- The gauge will be placed such that the bottom of the gauge is resting on the top of the stream bed;
- The gauge will be attached using No. 8 round-head screws and will be placed with the graduated markings facing outward;

- The water level will be recorded at the time of installation. A grease pencil will be used to mark the water level. Water levels, time and date will be recorded in a field logbook.

- The staff gauges will be surveyed by a Commonwealth of Virginia licensed surveyor concurrent with monitoring well/piezometer/ soil boring surveying. The surveyed point will be where the staff gauge intersects the top of the bridge. Water level elevations for each monitoring event will be converted to mean sea level (MSL) using the following method:

- Stream gauge elevation (FT-MSL) - Water level reading (FT) = Water level elevation of stream in FT MSL.

- Water levels will be monitored during a 3-day period. Site personnel will record water levels every 4 hours during daylight (est. 12 hours) resulting in 3 monitoring events per day during this survey.

- Water levels will also be recorded during each monitoring well sampling event.

- Tidal cycles (i.e. high and low tides) for each day of monitoring will be obtained to compare water levels at tidally-influenced streams.

4.7 TEST PIT EXCAVATION

Test pits will be used to investigate and define possible contamination associated with geophysical anomalies identified during the SI within several areas of the facility. Each proposed test pit will be designed to collect representative samples both vertically and laterally from each area under investigation. Excavation will be completed with a backhoe working from a stationary position, thus minimizing cross-contamination between sampling points.

The walls of the excavation will be kept as near vertical as possible. The maximum depth for test pits proposed during this phase of field activities is six (6) feet below ground surface. Excavated soil will be placed on 10-ply (minimum thickness) plastic sheeting placed adjacent to each test pit. Each trench will be immediately backfilled with trench soil upon trenching completion.

PID soil screenings will be performed by an ICF KE geologist immediately following filling of each backhoe bucket from every trench. Two to 3 vertical inches of soil will be removed from the center of the bucket to obtain an accurate PID reading from soil not exposed to air. Two samples per trench will be collected based on PID field screenings and visual signs of contamination. These samples will be jarred, and placed in an ice-packed cooler maintained at 4±2° C. Table 4-6 summarizes analytical requirements for test pit samples to be collected.

4.8 EQUIPMENT DECONTAMINATION PROCEDURES

Decontamination of equipment will be accomplished using the standard operating procedures provided in the QAPP. The following paragraphs briefly outline the SOPs that will be used for the WRF RI/FS.

4.8.1 Decontamination of Drill Rig and Downhole Equipment

Prior to beginning drilling operations, and between boring locations, the drill rig and other downhole equipment, will be steam-cleaned with USAEC approved gross decontamination water. This activity will

be performed in the leak-proof decontamination pad which will be constructed prior to commencement of field work. Water generated during this process will be periodically pumped from the decon pad into a holding tank to await proper disposal.

The decontamination process is briefly outlined below.

a. Steam clean using USAEC approved water;

b. Air dry.

4.8.2 Well Casing and Screen

Prior to use, well casing and screen materials will be decontaminated in accordance with the SOP, briefly outlined below. This activity will be performed in the leak-proof decontamination pad which will be constructed prior to commencement of field work.

a. Steam clean using water from the USAEC approved water source;

b. Rinse with deionized water;

c. Air dry; and

d. Wrap in plastic sheeting to prevent contamination during storage/transit.

4.8.3 Decontamination of Monitoring Well Purging Equipment

Submersible pumps and hoses used to purge groundwater from wells for development, or prior to the collection of groundwater samples will be decontaminated in accordance with the SOP briefly outlined below.

a. Pump a sufficient amount of non-phosphate detergent through the hose to flush out any residual purge water;

b. Scrub the exterior of the pump and hose with non-phosphate detergent;

c. Rinse the outside of the hose and pump with USAEC approved water;

d. Pump USAEC approved water through hose and pump to remove any remaining non-phosphate detergent;

e. Rinse outside of the pump and hose with deionized water; and

f. Wrap in plastic sheeting to prevent contamination during storage/transit.

4.8.4 Decontamination of Sampling Equipment

The following sections briefly outline the decontamination of the sampling equipment.

4.8.4.1 Water Level Indicator and Oil/Water Interface Probe. The decontamination procedure for water level indicators and oil/water interface probes is briefly described below:

a. Wash and scrub with non-phosphate detergent;

b. Rinse with USAEC approved water;

c. Rinse with deionized water; and

d. Wrap in plastic sheeting to prevent contamination during storage/transit.

4.8.4.2 Sampling Equipment. The decontamination procedure for sampling equipment is briefly described below:

a. Wash with non-phosphate detergent; scrub with a brush to remove any particulate matter surface film;

b. Rinse with USAEC approved water;

c. Rinse with 10% nitric acid solution;

d. Rinse with USAEC approved water;

e. Rinse with hexane;

f. Rinse with deionized organic-free water;

g. Air dry; and

h. Wrap in plastic sheeting to prevent contamination during storage/transit.

4.9 SAMPLE SHIPMENT/CHAIN OF CUSTODY

The Field Operations Leader will supervise and assist with sampling conducted at WRF. Samples will be labeled and preserved in the field as described in the QAPP. Sample chain of custody (COC) and Field Parameter Forms (FPF) identifying sample containers, chemical analysis requirements, and other field data required will be completed and affixed to each sample cooler and shipped to the laboratory. Upon arrival at the laboratory, the designated laboratory personnel will open the cooler, inspect and record the condition of each sample container, and sign the COC form. Any broken sample bottles or loosened sample jar lids will be reported to ICF KE so that additional sampling can be conducted.

Table 4-1
Locations, Depths, and Construction Materials for Existing Groundwater Monitoring Wells To Be Sampled For RI/FS

Monitoring Well No.[1]	Total Depth of Well (ft below ground surface)	Depth of Well Screened Interval (ft below ground surface)	Well Stickup (ft above surface)	Depth of Saturated Water Table (ft below ground surface)	Date Water Level Measured
AREE 1					
MW-7	37.5	32.0 - 37.5	3.00	24.86	5/18/94
MW-8	13.5	8.0 - 13.5	2.00	6.89	5/18/94
MW-9	11.1	5.6 - 11.1	2.00	3.09	5/18/94
MW-10	8.7	3.2 - 8.7	1.80	2.40	5/18/94
MW-11	9.5	4.0 - 9.5	1.00	2.99	5/18/94
MW-12	8.5	3.0 - 8.5	2.00	3.91	5/18/94
AREEs 2 and 5					
MW-1	15.5	10..3 - 15.4	2.60	9.77	5/18/94
MW-2	12.8	7.6 - 12.8	2.80	5.57	5/18/94
MW-3	12.6	7.5 - 12.6	2.90	5.25	5/18/94
MW-4	15.5	10.4 - 15.5	2.60	5.56	5/18/94
MW-5	25.5	20.3 - 25.5	2.80	4.97	5/18/94
MW-6[2]	15.5	14.4 - 15.5	2.50	6.41	5/18/94
Main Facility Compound					
MW-33	15.5	5.5 - 15.5	2.09	9.02	3/10/95
MW-34	13.5	3.5 - 13.5	2.48	7.39	3/10/95
MW-35	17.0	10 - 17	2.66	10.35	3/10/95
MW-37	14.5	4.5 - 14.5	-0.37	7.36	3/10/95
MW-38	14.5	4.5 - 14.5	-0.27	7.38	3/10/95
MW-39	14.5	4.5 - 14.5	2.81	9.68	3/10/95

1. All monitoring well casings and screens were constructed of 2-inch diameter, Sch 40 stainless steel. The screens of the wells located at AREE 1 were 0.02-inch slot, while all other wells were constructed with 0.01-inch slot screens.

2. This monitoring well will not be sampled due to a damaged well casing.

Table 4-2
Summary of Analytical Requirements for Groundwater Samples[1]

Sample ID	Approximate Depth of Well (feet bgs)[2]	Parameters			
		TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals	PAHs	PCTs	TPH
Background - Newly-Installed Monitoring Wells					
MW-52	35	X	X	X	X
MW-53	35	X	X	X	X
MW-54	35	X	X	X	X
MW-63	75	X	X	X	X
Downgradient of Former Dump Areas - Newly-Installed Monitoring Wells					
MW-75	35	X	X	X	X
MW-76	35	X	X	X	X
AREE 1 - Existing Monitoring Wells					
MW-7	13.5	X		X	
MW-8	37.5	X		X	
MW-9	8.7	X		X	
MW-10	11.1	X		X	
MW-11	9.5	X		X	
MW-12	8.5	X		X	
Newly-Installed Monitoring Wells					
MW-77	35	X		X	
MW-78	35	X		X	
MW-79	35	X		X	
MW-80	35	X		X	

Table 4-2 (Continued)
Summary of Analytical Requirements for Groundwater Samples[1]

Sample ID	Approximate Depth of Well (feet bgs)[2]	Parameters			
		TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals	PAHs	PCTs	TPH
AREEs 2 and 5 - Existing Monitoring Wells					
MW-1	15.5	X	X	X	X
MW-2	12.7	X	X	X	X
MW-3	12.6	X	X	X	X
MW-4	15.5	X	X	X	X
MW-5	25.5	X	X	X	X
Newly-Installed Monitoring Wells					
MW-68	35	X	X	X	X
MW-69	35	X	X	X	X
MW-70	35	X	X	X	X
MW-71	35	X	X	X	X
MW-72	35	X	X	X	X
MW-73	35	X	X	X	X
MW-74	35	X	X	X	X
MW-81	35	X	X	X	X
MW-82	75	X	X	X	X
MW-83	75	X	X	X	X
AREE 4 - Newly-Installed Monitoring Wells					
MW-64	35	X	X	X	X
MW-66	35	X	X	X	X
MW-67	35	X	X	X	X
AREE 6A - Newly-Installed Monitoring Well					
MW-65	35	X		*	

Table 4-2 (Continued)
Summary of Analytical Requirements for Groundwater Samples[1]

Sample ID	Approximate Depth of Well (feet bgs)[2]	Parameters			
		TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals	PAHs	PCTs	TPH
AREE 6B - Newly-Installed Monitoring Well					
MW-60	35	X	X	*	X
AREE 7 - Newly-Installed Monitoring Well					
MW-59	35	X	X	*	X
Downgradient of Main Compound - Newly-Installed Monitoring Well					
MW-61	35	X	X	*	X
AREEs 11, 17, 22, 23b, 24a,b - Existing Monitoring Well					
MW-39	14.5	X	X	X	X
Newly-Installed Monitoring Wells					
MW-55	35	X	X	X	X
MW-56	35	X	X	X	X
MW-57	35	X	X	X	X
MW-58	35	X	X	X	X
MW-62	75	X	X	X	X
AREE 8 - Existing Monitoring Wells					
MW-33	15.5	X	X	*	X
MW-34	13.5	X	X	*	X
AREE 12 - Existing Monitoring Wells					
MW-37	14.5	X	X	*	X
MW-38	14.5	X	X	*	X

Table 4-2 (Continued)
Summary of Analytical Requirements for Groundwater Samples[1]

Sample ID	Approximate Depth of Well (feet bgs)[2]	Parameters			
		TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals	PAHs	PCTs	TPH
AREE 14 - Existing Monitoring Well					
MW-35	17	X	X	*	X

1 Duplicate samples will be collected at a frequency of approximately 10% of the total number of samples. Rinse blanks will be collected at a frequency of approximately 5% of the total number of samples, or one per day, whichever results in fewer samples. One trip blank will be included in each sample cooler that contains an aqueous sample for VOC analysis.

2 bgs - below ground surface

* If PCBs are detected in a sample, the laboratory will be instructed to analyze the sample for PCTs.

Table 4-3
Summary of Analytical Requirements for Subsurface Soil Samples[1]

Site ID	Approximate Depth of Borehole (feet bgs[2])	Field Sample Number	Parameters			
			TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals	PAHs	PCTs	TPH
Background						
MW-52	35	A-C	X	X	X	X
MW-53	35	A-C	X	X	X	X
MW-54	35	A-C	X	X	X	X
Downgradient of Former Dump Areas						
MW-75	35	A-C	X	X	X	X
MW-76	35	A-C	X	X	X	X
PZ-13	25	A-C	X	X	X	X
AREE 1						
MW-77	35	A-C	X		X	
MW-78	35	A-C	X		X	
MW-79	35	A-C	X		X	
MW-80	35	A-C	X		X	
AREEs 2 and 5						
MW-68	35	A-C	X	X	X	X
MW-69	35	A-C	X	X	X	X
MW-70	35	A-C	X	X	X	X
MW-71	35	A-C	X	X	X	X
MW-72	35	A-C	X	X	X	X
MW-73	35	A-C	X	X	X	X
MW-74	35	A-C	X	X	X	X
MW-81	35	A-C	X	X	X	X
PZ-12	25	A-C	X	X	X	X
RISB6	25	A-C	X	X	X	X

Table 4-3 (Continued)
Summary of Analytical Requirements for Subsurface Soil Samples[1]

Site ID	Approximate Depth of Borehole (feet bgs[2])	Field Sample Number	Parameters			
			TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals	PAHs	PCTs	TPH
AREE 4 - Newly-Installed Monitoring Wells						
MW-64	35	A-C	X	X	X	X
MW-66	35	A-C	X	X	X	X
MW-67	35	A-C	X	X	X	X
AREE 6A - Newly-Installed Monitoring Well						
MW-65	35	A-C	X		*	
AREE 6B - Newly-Installed Monitoring Well						
MW-60	35	A-C	X	X	*	X
AREE 7 - Newly-Installed Monitoring Well						
MW-59	35	A-C	X	X	*	X
Downgradient of Main Compound - Newly-Installed Monitoring Well						
MW-61	35	A-C	X	X	*	X
AREEs 11, 17, 22, 23b, 24a,b						
MW-55	35	A-C	X	X	X	X
MW-56	35	A-C	X	X	X	X
MW-57	35	A-C	X	X	X	X
MW-58	35	A-C	X	X	X	X
RISB1	25	A-C	X	X	X	X
RISB2	25	A-C	X	X	X	X
RISB3	25	A-C	X	X	X	X
RISB4	25	A-C	X	X	X	X
RISB5	25	A-C	X	X	X	X

Table 4-4
Summary of Analytical Requirements for Surface Soil Samples[1]

Sample ID	TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals	PAHs	PCTs	TPH
	Parameters			
Background				
RIBK1 - RIBK5	X	X	X	X
AREE 1				
RISS1 - RISS4	X		X	
AREEs 2 and 5				
RISS5 - RISS9	X	X	X	X
AREE 3				
RISS10 - RISS12	X		*	
AREE 4				
RISS13 - RISS16	X	X	X	X
AREE 6A				
RISS17 - RISS23	X		*	
AREE 6B				
RISS24 - RISS25	X	X	*	X
AREEs In The Vicinity of Building 202 (AREEs 11, 17, 22, 23(b), 24(a), 24(c), And 24(d))				
RISS51 - RISS53	X	X	X	X
Facility-Wide Sampling				
RISS26 - RISS50	X	X	*	

1 Duplicate samples will be collected at a frequency of approximately 10% of the total number of samples. Rinse blanks will be collected at a frequency of approximately 5% of the total number of samples, or one per day, whichever results in fewer samples. One trip blank will be included in each sample cooler that contains an aqueous sample for VOC analysis.

* If PCBs are detected in a soil sample, the laboratory will be instructed to analyze the sample for PCTs.

Table 4-5
Summary of Analytical Requirements for Surface Water/Sediment Samples[1]

Site ID	Parameters			
	TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals	PAHs	PCTs	TPH
Background				
RIBKSW1 - RIBKSW5	X	X	X	X
RIBKSED1 - RIBKSED5	X	X	X	X
Marumsco Creek				
RISW1, 2, 5, 6, 13, 19, 20, 21	X		X	X
RISED1, 2, 5, 6, 13, 19, 20, 21	X		X	X
Drainage Creek Between the Pond and Marumsco Creek				
RISW10, 11, 12	X	X	X	X
RISED10, 11, 12	X	X	X	X
The Pond				
RISW7, 8, 9	X		X	X
RISED7, 8, 9	X		X	X
Western WRF Creek				
RISW25 - 38, 40 - 42	X	X	X	X
RISED25 - 38, 40 - 42	X	X	X	X
Occoquan Bay				
RISW3, 14 - 18, 24, 39	X	X	X	X
RISED3, 14 - 18, 24, 39	X	X	X	X
Southern Drainage Creeks				
RISW4, 22, 23	X	X	X	X
RISED4, 22, 23	X	X	X	X

Table 4-5 (Continued)
Summary of Analytical Requirements for Surface Water/Sediment Samples[1]

Site ID	Parameters			
	TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals	PAHs	PCTs	TPH
Northern WRF Creek				
RISW43, 44, 45	X		X	X
RISED43, 44, 45	X		X	X

1 Duplicate samples will be collected at a frequency of approximately 10% of the total number of samples. Rinse blanks will be collected at a frequency of approximately 5% of the total number of samples, or one per day, whichever results in fewer samples. One trip blank will be included in each sample cooler that contains an aqueous sample for VOC analysis.

Table 4-6
Summary of Analytical Requirements for Test Pit Samples[1]

Site ID	Field Sample Number	Parameters			
		TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals	PAHs	PCTs	TPH
AREE 1					
TP1	A & B	X		X	
TP2	A & B	X		X	
AREEs 2 and 5					
TP3	A & B	X	X	X	X
TP4	A & B	X	X	X	X
AREE 3					
TP13	A & B	X		*	
TP14	A & B	X		*	
AREE 4					
TP5	A & B	X	X	X	X
TP6	A & B	X	X	X	X
TP7	A & B	X	X	X	X
TP8	A & B	X	X	X	X
TP9	A & B	X	X	X	X
TP10	A & B	X	X	X	X
TP11	A & B	X	X	X	X
TP12	A & B	X	X	X	X
AREE 6A					
TP15	A & B	X		*	
TP16	A & B	X		*	
TP17	A & B	X		*	

Table 4-6 (Continued)
Summary of Analytical Requirements for Test Pit Samples[1]

Site ID	Field Sample Number	Parameters			
		TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals	PAHs	PCTs	TPH
AREE 6B					
TP18	A & B	X	X	X	X
TP19	A & B	X	X	X	X
TP20	A & B	X	X	X	X

1 Duplicate samples will be collected at a frequency of approximately 10% of the total number of samples. Rinse blanks will be collected at a frequency of approximately 5% of the total number of samples, or one per day, whichever results in fewer samples. One trip blank will be included in each sample cooler that contains an aqueous sample for VOC analysis.

* If PCBs are detected in a soil sample, the laboratory will be instructed to analyze the sample for PCTs.

5.0 SITE SAFETY PROCEDURES AND LOGISTICS

ICF KE is committed to protecting the health and safety of its employees. Employees assigned to this project will receive sufficient training to recognize and evaluate hazards likely to be encountered during field activities. In addition, any ICF KE employee who will be working at WRF will be medically monitored and receive basic health and safety training as specified under 29 CFR 1910.120 and in the ICF KE Health and Safety Program Manual.

Health and safety procedures are fully described in the Health and Safety Plan (USAEC, 1994a) and addenda (USAEC, 1994b and USAEC, 1995) developed for the site. This plan will be enforced by the Corporate Health and Safety Officer and Site Health and Safety Officer and it includes:

a. Identification of hazardous materials likely to be encountered at the site, their hazard potential, threshold, and other exposure limits;

b. Personal protective equipment requirements;

c. Monitoring equipment requirements;

d. Decontamination requirements and procedures; and

e. Contingency procedures in the event of a fire, medical emergency or other mishap/accident.

Information in this section is presented for ease of reference only, and is not intended to be a complete discussion. Details are provided in the Health and Safety Plan (USAEC 1995).

5.1 PERSONAL PROTECTIVE EQUIPMENT

Site activities will be initiated in modified Level D (as described in the Health and Safety Plan Addendum, USAEC 1995), which consists of the following:

(1) Dry Operations (without exposure to potentially contaminated groundwater or other hazardous liquids)

- Coveralls;
- Hard hat (within 25 feet, or length of longest drill stem component, from the rig);
- Safety glasses;
- Snake chaps;
- Steel-toed work boots;
- Full-face air purifying respirator (available for emergency use).

(2) Wet Operations (where exposure to potentially contaminated groundwater or other hazardous liquids could occur)

- Chemical-resistant disposable outer coveralls (e.g. Tyvek™)
- Work clothing (beneath outer coveralls);
- Hard hat (within 25 feet, or length of longest drill stem component, from the rig)
- Safety glasses, faceshield, or goggles
- Steel-toed shoes (with chemical resistant disposable cover)
- Chemical-resistant gloves: nitrile (outer), PVC or latex (inner)
- Hearing protection (as required);

- Full-face air purifying respirator (available for emergency use).

Respiratory protection is not required during drilling and sampling activities, unless otherwise prescribed, provided levels of organic vapors in the breathing zone are less than 5 ppm. Air purifying respirators are to be worn when levels of organic vapor in the breathing zone are between 5 and 25 ppm.

If the level of organic vapors in the breathing zone exceeds 25 ppm, personnel will move in an upwind direction away from the borehole. The Site Health and Safety Officer (SHSO) will don tyvek coveralls and SCBA and return to the borehole for additional monitoring of vapors with the PID, FID and Draeger tubes. If the organic vapor concentration remains greater than 25 ppm, no further drilling will be permitted until a sample of the media is collected and analyzed for volatile organics and subsequent hazards have been assessed.

(1) Level C - Consists of the above Level D equipment with the addition of an air purifying respirator with organic vapor/high efficiency particulate air (HEPA) combination cartridges.

(2) Level B - Consists of the above Level D equipment with the addition of a pressure demand airline respirator, or a pressure demand self-contained breathing apparatus (SCBA). An escape SCBA is required when using an airline respirator in oxygen deficient atmospheres.

(3) Level A will not be used on this project.

Circumstances that would require an upgrade in PPE are discussed in the addendum modification to Section 6.0 of the Health and Safety Plan (USAEC, 1995). Only the SHSO has the authority to downgrade the level of protection.

5.2 AIR MONITORING FOR HEALTH AND SAFETY

Personal air sampling will be conducted for chemicals in accordance with the OSHA standards. Air monitoring instruments to be used include an oxygen meter, and a PID or FID for the monitoring of organic vapors (the FID is recommended). Instrument-based action levels to be used are discussed in the addendum modification to Section 6.0 of the Health and Safety Plan. In addition to the PID/FID, a benzene Draeger pump and indicator tubes will be used to identify known contaminants in the work area when the PID/FID Level C action level is exceeded.

5.3 ON-SITE COMMUNICATIONS

If more than one sampling team is working at WRF, each sampling team will carry a hand-held radio for communication between teams, and radio checks will be conducted at regular intervals. In addition, a cellular telephone will be carried by one of the sampling teams in case the need arises to communicate with security or emergency personnel.

5.4 SITE ACCESS

Site security is maintained continuously at WRF. Field activities are permitted to be conducted from dusk until dawn, seven days a week. However, a list of site personnel to be on site must be submitted to the WRF security office no later than 24 hours prior to arrival at the site. Personnel must check in daily with the guard shack.

6.0 ECOLOGICAL ASSESSMENTS

An ecological assessment of the WRF will be conducted by ICF KE. Three primary goals of the ecological assessment are to:

1) determine the types and spatial distribution of habitats on WRF;

2) help evaluate the presence of endangered or threatened species at WRF; and

3) provide sufficient information on the flora and fauna of WRF to aid in the selection of potential ecological receptors and contaminant pathways for the ecological risk assessment.

To achieve these goals, the ecological assessment shall include a general evaluation and description of the terrestrial habitats, aquatic habitats, a wetlands delineation, and chemical tissue residue analyses of finfish and clam tissues previously collected from WRF. To gather information on WRF, existing documents will be reviewed for ecological information and relevant state and federal agencies will be contacted.

6.1 ASSESSMENT OF HABITATS AND GENERAL ECOLOGY OF WRF

A site walkover will be conducted, during which observations will be made and recorded concerning the general distribution of habitats types on WRF, any sensitive habitats observed, and any observed or suspected ecological impacts. Aerial photographs of WRF will be reviewed, and any habitat features observed will be ground-truthed. The ecological assessment shall provide information on ecologically important receptors or any threatened and endangered species utilizing the habitats of WRF. During the site walkover a canoe will be used to access the streams and ditches on WRF to evaluate the sediments and surface waters and select potential sample locations. At several locations within the aquatic habitats, water quality parameters (dissolved oxygen, salinity, conductivity, temperature, pH, redox, and percent saturation of dissolved oxygen) will be measured and recorded. Sediments will be examined and any physical and biological observations will be recorded.

6.1.1 Wetlands Delineation

A jurisdictional wetland delineation of the entire WRF site will be conducted following the guidelines specified in the 1987 version of U.S. Army Corps of Engineers Wetlands Delineation Manual (USACE 1987). Soil Conservation Survey maps, National Wetlands Inventory maps, aerial photography, and previous investigations will be reviewed prior to field determinations. The field determinations will begin with a detailed site walk to investigate topography, drainage patterns, and obvious water-holding areas. Potential jurisdictional wetlands will be inspected for evidence of hydric soils, hydric vegetation and hydrology. Where jurisdictional wetlands are found, the wetland/upland boundary will be determined, marked with flags, and the location of the boundary will be recorded using differential global positioning system (GPS). Methods and findings will be summarized in a wetland delineation report. The wetlands delineation will be conducted in the late spring of 1995.

6.1.2 Residue Analyses

The most direct way to document exposure in an organism is to measure chemical residues in biological tissues. As part of the ecological assessment, residue analyses will be used to evaluate the potential for contamination by determining the concentration of contaminants in the finfish and *Rangia cuneata* samples previously collected from WRF. These analyses are important for predicting the effects of contaminants on wildlife viability, either as a result of direct contact with abiotic media or accumulation through the food

web. The finfish were collected (November 8 to 10, 1994) from Marumsco Creek, AREE 22, and the pond. The *R. cuneata* were collected through a live-box experiment conducted at WRF during the late fall of 1994. Live boxes were placed at eight locations distributed throughout the creeks and surrounding waters of WRF. ICF KE will have chemical residue analyses performed on the finfish and clam tissues. The tissue residue data will be interpreted and included in subsequent reports.

6.1.3 Rationale for Clam Sampling

Bioaccumulation of chemicals will occur over time. The longer the organism is exposed to the chemicals, the more chemicals will be accumulated, to a point. Generally, metals will reach the maximum body concentration within days. Typically, organic compounds take longer; however, maximum body concentration will generally occur within one month. By selecting the samples with the longest exposure time, the most conservative estimate of the amount of accumulated compounds will be determined. In order to ensure enough biomass for the analyses, the latest sample period with adequate biomass was selected for analysis. Both live and dead sample fractions at each location were selected for analysis. The concentrations of the samples will be compared with the time 0 control sample and the background sample, station 8. If the concentration of contaminants is higher in the tissue samples than in the control samples, the earlier samples from that location will be analyzed. By plotting the concentrations of contaminants in the tissue versus time, the maximum concentrations can be estimated. A summary of proposed tissue analyses is presented in Table 6-1.

Table 6-1
Summary of Proposed Tissue Analyses

Clam Tissue Breakdown		
Location/Control Sample	**Status**	**Date Collected[1]**
1	live	Nov 21, 22
1	dead	Nov 21, 22
2	live	Dec 5, 6
2	dead	Dec 5, 6
3	live	Dec 5, 6
3	dead	Oct 24, 25
4	live	Dec 5, 6
4	dead	Oct 24, 25
5	live	Dec 5, 6
5	dead	Oct 24, 25
6	live	Nov 7, 8
6	dead	Nov 21, 22
7	live	No survivors
7	dead	Oct 25, 26
8	live	Dec 5, 6
8	dead	Nov 7, 8

1 All samples were collected in 1994.
Analytical Parameters: PAHs, TCL pesticides/PCBs, PCTs, mercury, and lead.

Table 6-1 (Continued)
Summary of Proposed Tissue Analysis

Fish Tissue Breakdown									
Location	**Bass**	**Y Perch**	**W Perch**	**Carp**	**Eel**	**Catfish**	**Sunfish**	**Black Crappie**	**Total**
Total Caught									
Pond (9)	5	0	10	0	0	4	0	0	19
Ditch (11)	6	0	0	3	9	0	10	10	38
Marumsco (10)	0	7	10	2	0	0	10	1	30
TOTAL									87
Fillets									
Pond (9)	5	0	5	0	0	4	0	0	14
Ditch (11)	5	0	0	3	5	0	5	5	23
Marumsco (10)	0	5	5	0	0	0	5	0	15
TOTAL									52
Whole Body									
Pond (9)	0	0	5	0	0	4*	0	0	9
Ditch (11)	0	0	0	3*	4	0	5	5	17
Marumsco (10)	0	0	5	0	0	0	5	0	10
TOTAL									36

* The carcasses will be analyzed to contribute to the ecological risk assessment.
Analytical Parameters: TCL pesticides/PCBs, PCTs, mercury, and lead.

7.0 PHYSICAL AND CHEMICAL ANALYSIS OF ENVIRONMENTAL SAMPLES

The following sections briefly described the methodologies used for the analysis of samples collected for the WRF RI/FS effort.

7.1 PHYSICAL ANALYSIS OF ENVIRONMENTAL SAMPLES

7.1.1 Physical Testing

Physical testing of soil samples will be performed by the contract laboratory. Physical analyses of soil samples will be performed in accordance with ASTM standards. Sediment samples will be tested for percent moisture, grain size distribution, and total organic carbon (TOC). One sample from each borehole (at the water table) will be tested for percent moisture, grain size distribution, TOC, Atterberg limits, and the USCS symbol will be assigned. The following methods will be used:

- Percent moisture: ASTM Method D 2216-80 (ASTM, 1991a)
- Grain size: ASTM Method D442-63 (ASTM, 1991b)
- TOC: ASTM Method D 2974-87 (ASTM, 1991c)
- Atterberg limits: ASTM Method D4318-84 (ASTM, 1991d)
- USCS: ASTM Method D2974-85 (ASTM, 1991e)

Physical testing of aqueous samples for water quality parameters will be performed at the time of sample collection. The following water quality parameters will be tested:

- Temperature;
- pH;
- Redox potential;
- Conductivity; and
- salinity.

7.1.2 Water Quality Parameters

Water quality parameters (temperature, pH, redox potential, salinity, and dissolved oxygen) will be monitored at the time of aqueous sample collection using field test and measurement equipment.

7.2 CHEMICAL ANALYSIS OF ENVIRONMENTAL SAMPLES

Chemical analyses for the WRF RI/FS will be performed by Environmental Science and Engineering (ESE) in Gainesville, FL. The following sections identify the chemical analytical methods used for the WRF RI/FS.

7.2.1 Target Compound List Volatile Organic Compounds

Target Compound List (TCL) volatile organic compounds (VOCs), as identified in the QAPP, will be analyzed by USEPA SW-846 Method 8240, performance demonstrated in accordance with U.S. Army Environmental Center Guidelines for the Implementation of ER 1110-1-263 for USAEC Projects, May 1993.

7.2.2 Target Compound List Semivolatile Organic Compounds

TCL semivolatile organic compounds (SVOCs), as identified in the QAPP, will be analyzed by USEPA SW-846 Method 8270, performance demonstrated in accordance with U.S. Army Environmental Center Guidelines for the Implementation of ER 1110-1-263 for USAEC Projects, May 1993. In addition, samples analyzed for TPH, or where SVOCs were previously non-detect, samples will also be analyzed using USEPA SW-846 Method 8310, performance demonstrated in accordance with USAEC guidelines (USAEC, 1994).

7.2.3 Polycyclic Aromatic Hydrocarbons

In order to meet the WRF RI/FS ARARs, PAHs as identified in the QAPP, will be analyzed using USEPA SW-846 Method 8310, performance demonstrated in accordance with U.S. Army Environmental Center Guidelines for the Implementation of ER 1110-1-263 for USAEC Projects, May 1993.

7.2.4 Target Compound List Pesticides/Polychlorinated Biphenyls

TCL pesticides/polychlorinated biphenyls (PEST/PCBs), as identified in the QAPP, will be analyzed by USEPA SW-846 Method 8080, performance demonstrated in accordance with U.S. Army Environmental Center Guidelines for the Implementation of ER 1110-1-263 for USAEC Projects, May 1993.

7.2.5 Polychlorinated Triphenyls

Polychlorinated triphenyls, as identified in the QAPP, will be analyzed based on article "Novel Chlorinated Terphenyls in Sediments and Shellfish of an Estuarine Environment", Environmental Science and Technology, Vol. 24, No. 11, 1990. This method has been modified to incorporate quantitation by Mass Spectrometry (MS) and was performance demonstrated in accordance with U.S. Army Environmental Center Guidelines for the Implementation of ER 1110-1-263 for USAEC Projects, May 1993.

7.2.6 Target Analyte List Metals

Samples will be analyzed for Target Analyte List (TAL) metals, as identified in the QAPP, using inductively coupled argon plasma (ICP). Where reporting limits lower than those provided by ICP are required by the ARARs, select metals will be analyzed by alternative instrumentation. The alternative instrumentation includes ICP-MS (aqueous samples), Graphite Furnace Atomic Absorption (GFAA) (solid samples), and Cold Vapor Atomic Absorption (CVAA)(solid and aqueous). Methods for the analysis of metals have been performance demonstrated for each of the above instruments. A detailed description of instrumentation and methodology is provided in the QAPP.

7.2.7 Total Petroleum Hydrocarbons

Samples will be analyzed for total petroleum hydrocarbons (TPH) using USEPA SW-846 Method 8015, performance demonstrated in accordance with U.S. Army Environmental Center Guidelines for the Implementation of ER 1110-1-263 for USAEC Projects, May 1993.

7.3 QUALITY CONTROL SAMPLES

Quality control (QC) criteria, including standard operation procedures (SOPs) for the WRF RI/FS are defined in detail in the QAPP, Volume II, of the Sampling and Analysis Plan. This section summarized QC samples that will be collected for the Quality Assurance Program for the WRF RI/FS.

7.3.1 Field Quality Control Samples

QC samples to be collected for the WRF RI/FS include duplicates, rinse blanks, trip blanks, and drilling materials.

Duplicate Sample. Duplicate samples are samples introduced into the train of environmental samples to allow for monitoring of the performance of the sampling SOPs. Duplicates will be collected concurrently and with the same procedures as the environmental samples. Duplicate samples will be collected at a frequency of approximately 10% of the total number of environmental samples.

Trip Blank. Trip blanks are samples containing deionized, organic-free water, that are transported along with the samples to evaluate the possibility that VOC contamination was introduced during sample transportation and shipment. The contract laboratory, ESE, will prepare these samples. One trip blank will be included in each sample cooler that contains an aqueous sample for VOC analysis.

Rinse Blanks. Rinse blanks are samples collected from the equipment after decontamination, and are used to monitor for cross-contamination between sample locations. Rinse blanks will be collected at a frequency of approximately 5% of environmental samples or one per day, whichever results in fewer samples. Rinse blanks will be analyzed for the same parameters as the associated environmental samples.

Drilling Materials. Samples of raw bentonite, sand, and grout mixture will be collected for chemical analysis to verify that these materials are free of contamination. The samples will be analyzed for metals, PCBs and PCTs.

7.3.2 Determination of a Decontamination Water Source

The source of decontamination water to be used for rough wash and rinse procedures during sampling activities at WRF will be the fire hydrant located next to Building 202 on the main compound. Prior to the initiation of field activities, a field blank will be collected. The water will be sampled and submitted to a laboratory for analysis of TCL VOCs, TCL SVOCs (and PAHs), TCL pesticides/PCBs, TAL metals, and TPH. Water to be used for decontamination of sampling equipment must be deionized, organic-free water. Results from this sample will be available prior to the beginning of sampling activities and the water must be approved by USAEC as a decontamination water source.

The procedures to be used for collection of the fire hydrant sample are as follows:

- The water will be allowed to flow at a high rate for one minute.
- The flow rate will be reduced to a trickle.
- The sample containers will be triple-rinsed with the water to be sampled.
- The sample containers will be filled in the order of decreasing volatility: VOCs, SVOCs, pesticides/PCBs, PCTs, TPHs, metals, and water quality parameters to include pH, temperature, redox potential, salinity, and conductivity.

8.0 DATA MANAGEMENT

The section describes the data management system utilized for the WRF RI/FS.

8.1 INSTALLATION RESTORATION DATA MANAGEMENT INFORMATION SYSTEM (IRDMIS)

The Installation Restoration Data Management Information System (IRDMIS) is an integrated system for the collection, validation, storage, retrieval, and presentation of Installation Restoration and Base Closures data. IRDMIS PCTool is a major component of IRDMIS, which provides the ability to enter chemical and geotechnical data in support of the USAEC Installation Restoration and Base Closure Programs. Data collected under the WRF RI/FS will be stored in IRDMIS.

Data generated during this project for entry into the IRDMIS will consist of geotechnical data and sampling/analytical data as well as monitoring well, soil boring, piezometer and staff gauge survey data. Data management will begin when ICF KE transmits a request for analytical services to the laboratory, stating the number, type, sample numbers, methods for analysis, and any other information necessary for the laboratory to plan a particular job. Geotechnical data generated during the WRF RI/FS will be input to IRDMIS by the ICF KE Data Management personnel.

8.1.1 Geotechnical Data Management

Five types of IRDMIS geotechnical data files will be generated by the field investigation activities during the RI to be conducted at the WRF. These files include:

- Geotechnical Map File (GMA) which contains location information about environmental samples;
- Geotechnical Field Drilling File (GFD) which contains information about drilling operations, descriptions of lithology encountered, soil sampling descriptions, and depth groundwater was first encountered;
- Geotechnical Well Construction File (GWC) which contains information about installation of the monitoring well, design and construction of the well to include: total depth; screen interval; annular materials (filter pack, bentonite, grout) stick-up; blank casing; and casing diameter;
- Geotechnical Groundwater Stabilized File (GGS) which contains data on depth to stabilized groundwater surface (from ground surface), date reading was collected, measurement tool, and source of data (instrument operator); and
- Geotechnical Aquifer Testing File (GAQ) which contains data on the type of aquifer test conducted, date and duration of test, and calculated aquifer permeability result.

These files are generated from field logbooks, boring logs, and field parameter forms used by the Site Geologists.

8.1.2 Chemical Analytical Data Management

Results of samples analyses performed by the laboratory are input into various chemical data files, including CGW (groundwater), CSO (surface and subsurface soil), CSW (surface water), CSE (sediment), CAT (analytical tissue), and CQC (QC). The laboratory is also responsible for validation of the data and for generation of error-free files. Sample information from sampling activities that are required by the laboratory will be submitted by the sampling team on field parameter forms along with the samples.

9.0 DISPOSAL OF INVESTIGATION-DERIVED WASTES

The following sections discuss the procedures for the disposal of WRF RI/FS investigation-derived wastes.

The preferred disposal option for the water generated during decontamination activities and well purging water is discharge through the local sanitary sewer system to the local publicly-owned treatment works (POTW). The local POTW for the Woodbridge area is the Mooney Treatment Facility. In order to discharge water to the sewer, pretreatment standards for the POTW must be met. The pretreatment standards for the Mooney Treatment Facility are presented in Table 9-1.

The preferred disposal option for uncontaminated soil boring cuttings is on-site disposal by spreading the soils on the ground in an approved location and seeding to promote vegetative cover. This option will only be exercised upon approval from WRF, USAEC, EPA Region III, and VDEQ.

9.1 DECONTAMINATION WATER

Water will be periodically pumped out of the decontamination pad into a tank located adjacent to the decontamination pad. A composite sample will be collected from the tank at the conclusion of all site activities. The composite sample will be comprised of a sample collected from the top of the tank and one from the bottom. The sample will be obtained using a Teflon™ double-check valve bailer with a 2-foot Teflon™-coated stainless steel leader and disposable nylon rope. The water will be analyzed for TCL VOCs, SVOCs, TPH, pesticides/PCBs, TAL metals, pH, corrosivity, cyanide, and sulfide. The results of these analyses will be compared to the pretreatment standards for the disposal facility. If the pretreatment standards are met, the data will be presented to the treatment facility and permission to discharge to the sanitary sewer will be obtained. If discharge volume limits are required by the treatment facility, then disposal will occur at the volume limits set by the treatment facility.

If the pretreatment standards are exceeded, a subcontractor will be contracted to dispose of the water at a wastewater recycling facility. If this option is exercised, manifests will be prepared for transportation and disposal. WRF will be listed on the manifest as the generator and an appointed representative from WRF will sign the manifests for off-site disposal.

9.2 PURGE WATER

Groundwater derived from both well development and pre-sample purge water will be containerized and labeled with well identification number, date, and water type, (i.e. development or purge water). The water will be kept segregated until the individual groundwater samples have been analyzed and the data validated. The analytical data will be used to determine disposal options on a well-specific basis. These analyses will be compared to the pretreatment standards for the Mooney Treatment Facility. If the pretreatment standards are met, the data will be presented to the treatment facility and permission to discharge to the sanitary sewer will be obtained. If discharge volume limits are required by the treatment facility, then disposal will occur at the volume limits set by the treatment facility. The drummed water may be consolidated into tanks if analyses for individual wells are similar enough to warrant compositing. For example, if 10 wells indicate that all analytes are non-detect, then that water would be combined in one storage vessel to eliminate large numbers of drums stored on site. The drums can be disposed of through a drum recycling center.

Table 9-1
Pretreatment Requirements for H. L. Mooney Wastewater Treatment Plant*

CONSTITUENT	LOCAL LIMIT (MG/L)
BOD	165
TSS	240
AMMONIA	20
CADMIUM	0.70
CHROMIUM	2.09
COPPER	3.86
CYANIDE	3.51
LEAD	0.21
MERCURY	0.15
NICKEL	22.37
SILVER	0.17
ZINC	0.19
ARSENIC	15.66
TOTAL PETROLEUM HYDROCARBONS	1.0
BENZENE	0.005
TOLUENE	0.002
ETHYLBENZENE	0.070
XYLENES	0.010
OTHER ORGANIC COMPOUNDS	RESPECTIVE MCL

* As required under Federal Regulation 40 CFR Parts 122 and 403 and Commonwealth of Virginia Regulation VR 680-14-01.

If the pretreatment standards are exceeded either for all the purge water or individual wells, a subcontractor will be contracted to dispose of the water at a wastewater recycling facility. If this option is exercised, manifests will be prepared for transportation and disposal. WRF will be listed on the manifest as the generator and an appointed representative from WRF will sign the manifests for off-site disposal.

9.3 PPE, SAMPLING EQUIPMENT, AND OTHER SOLID WASTE DISPOSAL

Prior to the initiation of site field activities, arrangements with the Prince William County Landfill or a local sanitary waste hauler will be made to place a dumpster at WRF for the disposal of PPE and disposable sampling equipment. All used personal protective equipment (PPE) will be securely contained in plastic bags placed in the dumpster. The contents of the dumpster will be periodically collected by the landfill or private waste hauler and transported to Prince William County Landfill for disposal.

The analytical data from the decontamination water analysis will serve as the basis for disposal options related to the disposal of the decontamination pad materials. The decontamination pad will be dismantled and placed in the dumpster dedicated to PPE and will be handled in the same manner as the disposal of PPE.

Prior to the initiation of site field activities, arrangements with the Prince William County Landfill or a local sanitary waste hauler will be made to place a dumpster at WRF for the disposal of solid waste. This material will be segregated from the dumpster dedicated for disposal of PPE and sampling equipment. The contents of the dumpster will be periodically collected by the landfill or private waste hauler and transported to Prince William County Landfill for disposal.

9.4 SOILS DERIVED FROM DRILLING ACTIVITIES

All soil cuttings generated as a result of drilling activities at WRF will be drummed, labeled, and transported to a main staging area near the decontamination pad. The soils from each boring will be kept segregated until the subsurface soil samples from each boring have been analyzed and the data validated. The analytical data will be used to determine disposal options on a boring-specific basis. If the analytical data indicate that the soils are within background ranges established for the site, then permission to spread the drummed soil out at an approved location at WRF will be requested. A subcontractor will be contracted to empty the drummed soil, spread the soil with a backhoe, and seed and straw the area to promote vegetative growth. The empty drums will be taken off site to a drum recycling facility for disposal.

If the soils exceed the background ranges, but are within the MCLs set for disposal at a municipal landfill, (according to 40 CFR Parts 240 through 259 and based on the permit specifications for the municipal landfill), then application will be made to dispose of the soils through this mechanism. All disposal permits will list WRF as the generator and permits will be signed by an appointed representative from WRF.

If neither of these options are acceptable, based on analytical data, then options for disposal at a regulated special waste landfill or a regulated hazardous waste landfill (according to 40 CFR Parts 260 through 272) will be arranged. All permits and manifests required for transportation and disposal will list WRF as the generator and all permits and manifests will be signed by an appointed representative from WRF.

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4,4-DDD - 4,4-1,1-Dichloro-2,2-bis(p-chlorophenyl)-ethylene
4,4-DDE - 4,4-Dichlorodiphenylethane
4,4-DDT - 4,4-Dichlorodiphenyltrichloroethane

ARARs - applicable or relevant and appropriate requirements
As - Arsenic
ASTM - American Society of Testing Materials
ATSDR - Agency for Toxic Substances and Disease Registry
AWQC - Ambient Water Quality Criteria
BCFs - bioconcentration factors
CEQ - President's Council on Environmental Quality
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CL-ML - low plasticity clay with silt
COR - Contracting Officer's Representative
CVAA - Cold Vapor Atomic Adsorption
DIUF - deionized ultrafiltered
EP - equilibrium partitioning
ER-L - effects range low
ER-M - effects range median
ESE - Environmental Science and Engineering
FEMA - Federal Emergency Management Agency
FFS - Focused Feasibility Study
FID - flame ionization detector
ft-amsl - feet above mean sea level
ft/ns - feet per nanosecond
GC - Gas Chromatography
GC/ECD - gas chromatography with electron capture detector
GC/MS - Gas Chromatograph/Mass Spectrometer
GFAA - Graphite Furnace Atomic Adsorption
GPR - ground penetrating radar
HEAST - Health Effects Summary Table
HEPA - high efficiency particulate air
HSWA - Hazardous and Solid Waste Amendments
Hz - hertz
i - hydraulic gradient
ICF KE - ICF Kaiser Engineers, Inc.
ICP - Inductively Coupled Argon Plasma
IDL - Instrument Detection Limit
IRDMIS - Installation Restoration Data Management Information System
IRIS - Integrated Risk Information System
K - hydraulic conductivity
K^d - distribution coefficient
LDRs - land disposal restrictions
LOAEL - lowest-observable-adverse-effect level
MCLs - Maximum Contaminant Levels
MCLGs - Maximum Contaminant Level Goals
MDL - Method Detection Limit
MS - Mass Spectrometer
MSs - matrix spikes
MSDs - matrix spike duplicates
NEPA - National Environmental Policy Act of 1969
NOAA - National Oceanic and Atmospheric Administration
NTU - nephelometric turbidity unit
OSHA - Occupational Safety and Health Administration
OSWER - Office of Solid Waste and Emergency Response
OU - Operable Unit
PC - personal computer
PCBs - polychlorinated biphenyls
PCTs - polychlorinated triphenyls
PID - photoionization detector
PPE - Personal Protective Equipment
PVC - polyvinyl chloride
QAPP - Quality Assurance Project Plan
QA/QC - Quality Assurance/Quality Control
RA - Risk Assessment
RCRA - Resource Conservation Recovery Act
RI - Remedial Investigation
RI/FS - Remedial Investigation/Feasibility Study
RF&P - Richmond, Fredericksburg, and Potomic Railroad
RPDs - relative percent difference
RTECS - Registry of Toxic Effects of Chemical Substances
S - storativity
SAP - Sampling and Analysis Plan
SARA - Superfund Amendments and Reauthorization Act of 1986
SARs - structure-activity relationships
SCBA - self-contained breathing apparatus
SDWA - Safe Drinking Water Act
SM - silty sand
S/N - signal-to-noise
SOPs - standard operating procedures
SOW - Statement of Work
SP - poorly graded sand
SQC - Sediment Quality Criteria
SQL - Sample Quantitation Limit
SSL - Special Screening Levels
SVOC - semivolatile organic compound
SWMUs - Solid Waste Management Units
T - Transmissivity
TAL - Target Analyte List
TBC - to-be-considered
TCL - Target Compound List
TETC - The Earth Technology Corporation
TICs - tentatively identified chemicals
TRVs - Toxicity Reference Values
TSS - Total Suspended Solids
UBK - Uptake Biokinetic
UCA - Upper Confined Aquifer
UCL - upper confidence limit
UCU - Upper Confining Unit
URL - Upper Reporting Limit
USAEC - United States Army Environmental Center
USACE - United States Army Corps of Engineers
USCS - Unified Soil Classification System
USEPA - U.S. Environmental Protection Agency
USFWS - U.S. Fish and Wildlife Service
USGS - United States Geological Survey
VDEQ - Virginia Department of Environmental Quality
VOCs - volatile organic compounds
VD - vertical dipole
WRF - Woodbridge Research Facility
WTA - Water Table Aquifer